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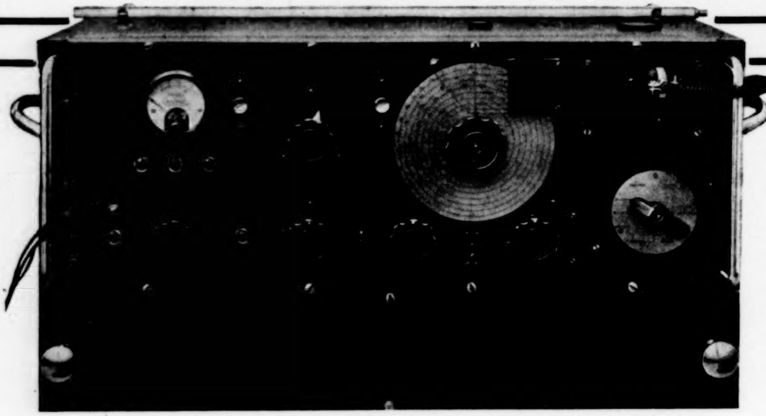

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THE
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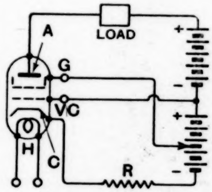
VOL. XV. JUNE, 1938 No. 177

Editorial

A New Type of Gas-filled Amplifying Valve

IN a recent number of the *Elektrotechnische Zeitschrift** a somewhat unusual type of valve was described by Johannes Nienhold which, although we feel justified in referring to it as a new type, is based upon patents dating back to 1916. Although containing gas or mercury vapour the valve, unlike the thyratron, is free from trigger action, and functions in a steady manner like a vacuum valve, so that it can be used for amplification and as a high-frequency generator. We gather that the valve, notwithstanding the references to patents of twenty years ago, is only just emerging from the development stage; up to the present it has been made for outputs of several hundred watts and for anode voltages up to 1 kilovolt. The principle can be explained by reference to the Figure. The indirectly heated cathode serves as the source of electrons but does not form the effective cathode of the valve. The effective cathode surface is the grid VC, and it is only the electrons which pass through this grid that take any part in the action of the valve. The grid VC thus serves as a virtual cathode and divides the total space into two separate spaces, an electron generating space and an electron control space. VC is made positive with respect to C, and the electrons emitted by C, together with those produced by ionisation of the *He*, *Ar*, or *Hg* atoms will arrive at VC. What happens to them then will depend on the potentials of the anode A and the control grid G. Thus the electrons passing through the meshes of VC into the space above—or outside it in the cylindrical form—are in exactly the same position as the electrons emerging from the cathode surface of the ordinary valve. The potential difference between VC and C must not exceed a certain figure, as otherwise the cathode C will be rapidly destroyed by ionic bombardment. For *Hg*, *Ar* and *Ne* this figure is about 25 volts, for *He* about 40 volts. The gas pressure must be such that satisfactory operation is obtained without exceeding these values. Lowering the voltage on VC, or increasing the gas pressure, would cause the electrons to pass through the meshes of VC with a reduced velocity, thus having the same effect as a reduction of filament temperature in an ordinary



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* March 31, 1938, p. 329.

valve. Having thus seen that the grid VC acts as a virtual cathode of great emissivity, let us turn our attention to the control space, which is, of course, also gas-filled. If constructed on normal lines, the control grid G, if given a negative potential, would attract and surround itself with a cloud of positive gas ions which would screen the remaining space from the controlling action of the grid. Nienhold gets over this difficulty by making the distance between VC and the anode A less than the mean free path of the electrons, so that the electrons which pass through the meshes of VC with such a velocity that, under the combined action of G and A, they reach A, do so with the probability of not colliding with a gas molecule *en route*. In the absence of ionisation between VC and A, characteristics should be obtained similar to those of a vacuum valve, and this is confirmed by experiment. The effect of the potentials of A and G will be felt by the electrons even before they emerge from the virtual cathode space, for the electric fields of A and G will penetrate through the meshes of VC to an extent depending on the geometry of the latter. The condition that the distances between VC, G and A must be less than the mean free path of an electron, that is, a few tenths of a millimetre, calls for very accurate construction, which, according to the author, is now possible with the help of the modern ceramic insulating materials with their low loss at high frequencies. The difficulties involved in using anode voltages of a kilovolt or more with electrodes so closely spaced are obvious, and are doubtless the reason why development has been so slow. An additional source of supply is required for the ionisation of the virtual cathode space, and the current taken by the control grid will not be negligible, but neither of these would present any great difficulty when using the valve as a generator, One advantage which is claimed is that, whereas in an ordinary valve the thermal capacity of the cathode makes it impossible to produce high-frequency variations in the anode current by varying the cathode temperature, it is a simple matter to vary the voltage of VC at a high frequency, which is equivalent to a variation of temperature of the virtual cathode. When using the valve as an amplifier the applied voltage can thus be made not only to affect the control grid G but also the virtual cathode VC, although, of course, power considerations have to be taken into account.

G. W. O. H.

BRUSSELS CHECKING STATION

The photograph shows apparatus for the checking of long- and medium-wave transmissions which has been installed in the new home of the Union Internationale de Radiodiffusion Checking Post in Brussels. New premises, which were specially built for the purpose, accommodate, on three floors, a considerable amount of new apparatus.

Application of Electrography in Television*

The Production of Large-Screen Pictures

By P. Selényi, Ph.D.

(Tungsram Research Laboratory)

THE problem of television pictures of large dimensions has lately been amply discussed by German authors. Professor Karolus lectured before the "Verein deutscher Elektrotechniker"[1]† on existing systems and Prof. Schröter has written a detailed account of the present state and possible extension of the "Multi-cell-table" systems.[2]

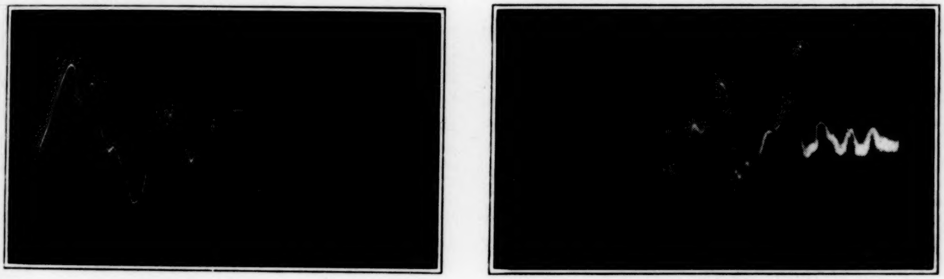
Both authors agreed that the author's electrographic system will possibly play a part in the solution of the problem. Although a series of publications has appeared in German on this subject[3] dealing mainly with the use of electrography in picture and facsimile transmission and in oscillography, problems of television receiving were only alluded to.

The present paper will give a short review of electrographic recording methods and will discuss in this connection the prospects of these methods in the realisation of large picture television.

The intermediate film method holds a unique position among all methods aiming at the projection of large television pictures, whether actually realised or only proposed. This is the only method which preserves the picture after reception in a visible and permanent condition ("optical storage of the picture," according to Prof. Schröter), so that it can be directly projected. This causes a double improvement:

(a) The projected television picture is as bright as an ordinary moving picture.

(b) It would be sufficient to transmit 17–20 pictures in the second, while a Braun-tube apparatus necessitates 50 picture/sec. If the projection of each single picture is twice interrupted by a rotary shutter—as in the usual projection of moving pictures—the resulting picture is quite free from flickering. In consequence of the reduced number of pictures in the second, the frequency range of the modulation may be reduced also.



(a) (b)

Fig. 1.—*Electric writing written on a hard-rubber plate with a metal tip. (a) developed on the front, (b) developed on the back.*

Two notorious disadvantages, however, more than counteract the two abovementioned advantages: (*a*) The time between reception and projection of the picture cannot be reduced under 2–3 minutes. (*b*) The film is extremely expensive. According to the authors referred to, it amounts to about 800 RM in the hour for normal films and 78 RM for narrow films. This practically rules out the intermediate film method except in very rare cases.

By substituting electrostatic recording (electrography) for photography the intermediate film method becomes at once

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* MS accepted by the Editor, September, 1937.

† See list of references at end of article.

applicable. Electrography consists in the preservation of the received signals on an insulating film by means of electrostatic charges resulting in an invisible electric picture, which may be developed by dusting over with a fine powder. The method is much cheaper than the photographic recording of the intermediate picture, and has practically no time lag.

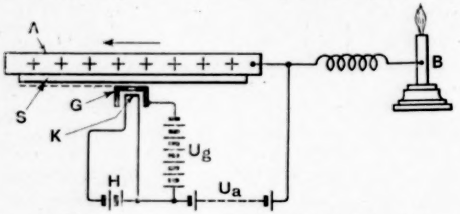


Fig. 2.—*Electrographic recording system.*

Instead of the expensive photographic film a relatively cheap insulating film may be used and it seems possible to use continuously a short, endless ribbon for the whole operation. Thus the working expenses of this process will be presumably quite low. The development by wiping over the film may take place immediately after the electric record is formed, so that a practically instantaneous picture reproduction is ensured.

We shall describe a very simple experiment before dealing with the methods of electrography. Take a thin well-planed hard-rubber plate, 0.25 to 0.5 mm. thick, and write on it with a rounded metal point. The path of the metal tip on the ebonite becomes charged with negative electricity because of the friction between the plate and the point. Dust a fine positively charged powder, e.g. lycopodium, by means of a rubber ball on the hard-rubber plate: the powder adheres to the charged lines on the plate, the invisible electric writing has been developed with utmost sharpness (see Fig. 1a). The writing can be developed on the back of the plate too, but the lines are not so sharp, owing to the divergence of the field (see Fig. 1b.)

The methods of electrography may be derived from this simple experiment by substituting either

(*a*) a well-defined beam of negative ions in free air or

(*b*) a cathode ray in vacuum,

in place of the metal writing tip.

Fig. 2 represents the first method (see publications a, b, c, and d). *K* is a hot cathode (a platinum wire of 0.1–0.2 mm. diameter, coated with barium oxide and energised by the battery *H*, *G* a control electrode (grid) consisting of a metal cap with a hole of about 0.5 mm. diameter. *A* is the anode covered with a sheet *S* of insulating material. The distances cathode-grid and grid-sheet must be as small as possible, about 0.5–1 mm. The arrangement operates in the following manner: Electrons emerge from the cathode, attach themselves to the gas molecules and are driven by the anode voltage U_a of 500–1,500 volts through the hole in *G* and are finally deposited on *S*, giving a negative charge to the latter. The anode may be moved with the sheet in the direction of the arrow and the ion beam then traces an invisible electric line on the sheet, capable of development. The width of the beam and hence that of the line is controlled by the grid-potential U_g, and a modulation of the latter induces a variation in the width of the line, a 100 per cent. modulation being effected with 5–10 V.

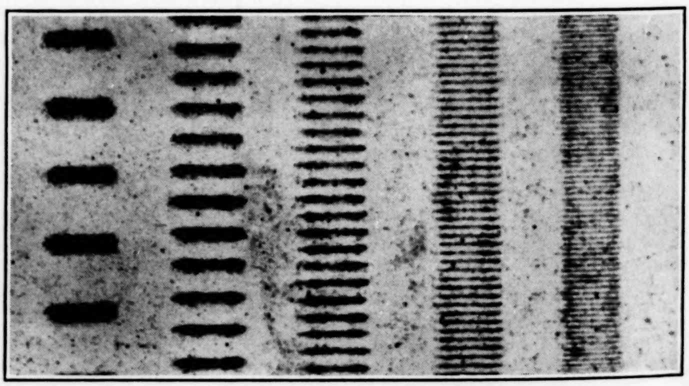


Fig. 3. — *Electrographic A.C. records* (*Frequencies*: 500, 1,000, 2,000 4,000, *and* 6,000 *c/s respectively*).

If the picture is not to be preserved the dust may be blown away from S with a strong blast of air and its electric charges neutralised with the Bunsen flame B: the sheet is then ready for a new record.

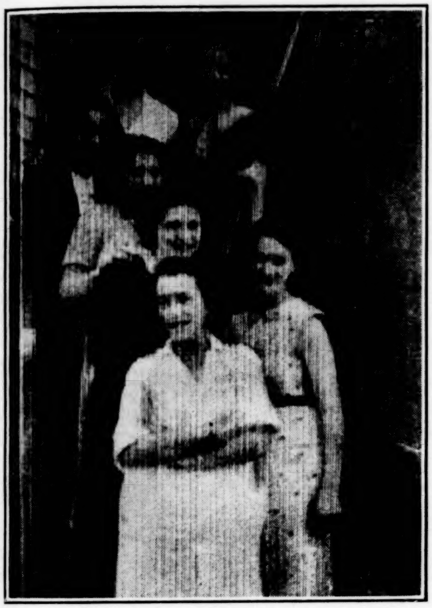


Fig. 4.—*Electrographically recorded picture, received on a paper coated with insulating varnish.*

The application of this method in recording various electric phenomena (time measurement, oscillography, sound recording, etc.) is described in the publications cited in reference 3. Fig. 3 is a 3.5 times magnified photograph of an oscillogram of alternating currents in a so-called "record of variable density." The frequencies of the currents were 500, 1,000, 2,000, 4,000 and 6,000 cycles per second; the speed of recording was 100 cm/sec. The oscillogram was recorded on paper impregnated with paraffin and it was developed by dusting over with asphalt powder. The record was expressly overmodulated in order to secure a high definition, so that the sinusoidal character of the current is not seen and the record degenerates into a system of dark and light lines.

The arrangement and function of the whole system is comparable with that of a Braun-tube or a triode, operated in the air instead of in vacuum.

The next step is still-picture and facsimile telegraphy. Experiments in this direction were performed with simple drum-apparatus, having a mechanically coupled pair of transmitting and receiving drums. Fig. 4 is a picture transmitted with this apparatus. This picture was received on a paper coated with black insulating varnish at a rate of 15 rotations per second and with an axial displacement of 0.3 mm. per rotation. Speed of recording: 1.8m./sec., total time of transmission: 15 sec. This apparatus was not fit for a higher speed of rotation[4] and a higher definition would be useless as long as the picture is developed with lycopodium powder with its relatively coarse grains[5].

It is clear, that this procedure is directly adaptable to television reception. The pictures will be written electrographically in a continuous series on an endless ribbon of insulating material, it will be developed by dusting over and then projected. After projection the dust will be blown off, the charged surface neutralised, and the ribbon will again

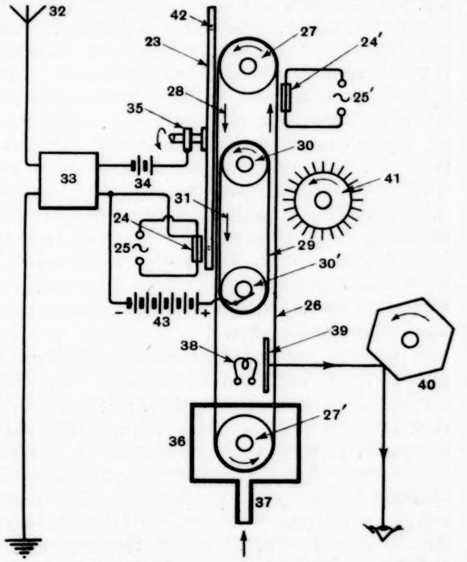


Fig. 5.—*Principal arrangement of an electrographic television receiver.*

be ready for reception. Fig 5, which is self-explanatory, contains the fundamental features of such an apparatus. (Reprinted from the British Patent No. 449824.)

The radio signals picked up by the aerial 32 are, after amplification and rectification, applied to the Nipkow disc 23, which is biased by the battery 34 and serves as control electrode for the long-shaped, indirectly heated cathode 24 of the electrographical recording system. The cathode is placed opposite the holes of the disc and perpendicularly to the plan of the drawing; it may be somewhat longer than the distance between two adjacent holes of the disc. The invisible electrical pictures are produced on the endless insulating ribbon 26, which is moved continuously by pulleys 27, 27′. The anode voltage 43 is applied to the endless metal ribbon 31, which adheres to the insulating ribbon and moves with the same velocity as the latter so that no disturbing frictional electric charges will be produced.

On rotating the Nipkow disc and moving the insulating ribbon, both synchronously with the sending apparatus, the invisible electrical pictures are recorded on the ribbon[6]. After recording, the film is dusted over (developed) in chamber 36 and the resulting picture viewed or projected by means of an optical arrangement (e.g. polygonal-mirror 40) which changes the continuous movement of the film into a discontinuous series of pictures. The powder is dusted off later with the rotating brush 41, and the charges are neutralised with a source of positive ions 24 (e.g. hot anode of Kunsmann). The whole process obviously resembles the intermediate film process; however, as already mentioned, many disadvantages of the latter are avoided.

Up to the present only a few crude experiments have been made towards the construction of the said apparatus; technical details will be omitted here. We may estimate, however, the possibilities of such a system, if we consider its mechanical, electrical and optical properties. The maximum peripheral velocity of the Nipkow disc is 130–150 metre/sec.; this maximum velocity however is generally attained with a disc, which rotates in vacuum. This would involve a reconstruction of the whole apparatus to enable the development, projection and dusting off to take place within a chamber at reduced pressure. This is a complication of the procedure, but the problem can surely be solved with present-day technique. Reckoning 16 pictures per second the total length at our disposition for *one* picture will be 130/16–150/16 metres; that is 8.1–9.4 metres. (The individual lines are to be added up into a single one.) The number of picture elements can be calculated by division of this length by the length of a side of the square picture element. Obviously all depends upon the dimensions of the picture element, i.e. upon the allowable width of the lines. This is determined by optical conditions[7]—viz., upon the possible minimum dimension of the powder particles which produce sufficient opacity for the satisfactory reproduction of the half tones in the picture.

It is known that colloidal metal sulphides become opaque in a layer of 2–3 microns. It remains to determine whether such a layer can be produced by electrostatic attraction. Particles 1/100 mm. diameter, however, give a sufficient opacity if the substance is appropriately chosen. Fig. 4 shows on the other hand that it is sufficient to write with lines 8.5–10 times as wide as the diameter of the particles to ensure a good reproduction of the half tones[8]. (In our case, width of the lines, 0.3 mm.; diameter of the lycopodium particles 30 to 35 microns.)

If a similar result is sufficient, the width of the lines has to be 0.1 mm. for a diameter of the powder particles of 0.01 mm. This means that the picture element is 0.1 × 0.1 mm. If the ratio $\frac{\text{line width}}{\text{particle diameter}}$ is 15 : 1 or 20 : 1 the side length of the picture element has to be 0.15 or 0.20 mm. Therefore the number of picture elements of a picture will vary between 40,000 $\left(=\frac{8\text{ m.}}{0.2\text{ mm.}}\right)$ and 90,000 $\left(=\frac{9\text{ m.}}{0.1\text{ mm.}}\right)$. If the proportion of the sides of the picture is 2 : 3 we arrive at 160–240 lines in a picture, so that this mechanical electrographic system would then yield very good quality television pictures[9].

It remains to discuss from the electrical standpoint the limits of speed of recording possible with this system. During recording the front side of the film is charged to anode potential. With a film thickness of $\frac{1}{4}$ mm. and a dielectric constant of 3, the capacitance of the film is 10 cm. per cm^2. Allowing for the half-tones, where the surface is only partially used, this capacitance may be reduced by a factor of $\frac{1}{2}$. For 1,000 V. anode potential we thus arrive at a charge of 5,000 volt-cm., that is, about 5.10^{-3} microcoulombs per cm.^{2} of the recorded picture. Our measurements indicate that the current of negative ions produced by a hot cathode in air reaches the value of 5 microamperes through an opening of 1 mm.^{2}. This current intensity suffices therefore to record 100,000 picture elements in the second.[10]

A hot cathode in vacuum gives several milliamperes per mm.^{2}, so that there will be no electrical difficulties if the apparatus works in vacuum.

We will now describe the second type of electrography using a cathode ray. The author first described such experiments in 1928–29, where the cathode rays, produced in a high vacuum hot cathode Braun-tube hit the *inner* surface of its glass bulb and the invisible curves obtained were developed on the *outside* of the bulb by dusting over with powder[11]. Fig. 6 (from the publication Ref. 11(g) shows this tube. 2 is the V-shaped hot cathode, 1 the control electrode with a central opening (Wehnelt-cylinder), 3 and 4 are two separate metallised surfaces (magnesium) with their leads 5 and 6. The magnesium films play the role of the anodes of the tube, and both halves of it function at the same time as deflecting plates, the deflecting voltage acting between them. The front of the tube 7 is coated with a black insulating varnish to make the dusted curves more readily visible[12].

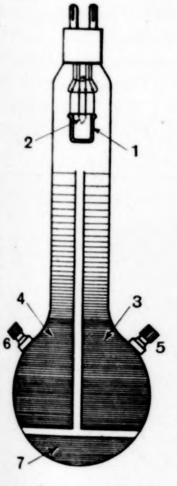


Fig. 6.—*Oscillograph tube, recording with the static charge of the cathode ray.*

Fig. 7 is a reproduction of curves recorded with this tube: it shows a series of ellipses obtained by combination of electric and magnetic deviating forces at a frequency of 50 c/s. The corresponding patent specifications[13] mention that the device may be used to receive broadcast pictures. However, the fact that the lines are not sharp after development is a great hindrance to the practical application of this instrument. Television brings another difficulty: it is difficult to imagine how the whole process of recording overdusting, projection and removing of the picture could be effected on the front of the tube 16 times per second. There are two ways out of this difficult situation: (*a*) The whole process is transferred into a chamber with reduced air pressure. The picture is recorded with a cathode ray on an endless ribbon moving with uniform velocity. Then it is developed, projected and removed. For this purpose it is only necessary to deviate the ray in one direction; thus it suffices that the cathode ray tube should only communicate with the recording part of the apparatus along a narrow slit. The pressure may be higher in the recording part of the apparatus without affecting the cathode ray part. (*b*) The cathode ray escapes from the tube through a slit covered with a Lenard-window and the whole recording device is placed before this window in the free atmosphere. (Both solutions are contained in a patent application of the Tungsram Co., which is not yet made public.)

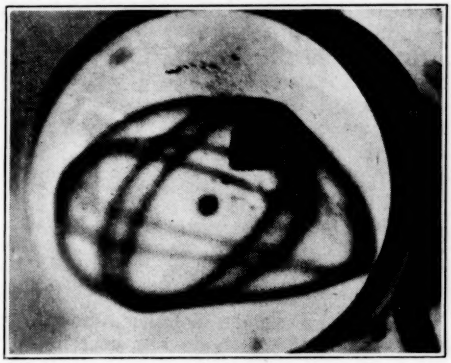


Fig. 7.—*Electrographical oscillograms obtained with the tube on Fig.* 6.

The second method can doubtless be worked out because a high voltage oscillograph tube is known to give sharp oscillograms on a photographic plate through a Lenard-window. We confirmed that electrographic records can be made on an insulating surface in this way[14], but the method requires further development. Fortunately a recent publication of two Japanese authors, who repeated the experiments with a Dufour-oscillograph, contains quantitative results sufficient to discuss the possibilities of solution[15]. These authors arrived at the following results: The sine curves of 10^5 cycle alternating current may be recorded on an ebonite plate with lycopodium powder as distinct lines 0.25 mm. broad if the anode voltage amounts to 65 kV. and the cathode ray current to 4 microamperes. (The lines were 0.5 mm. broad if they were developed on the back of the plate). The double amplitude of the sine curve was 1 cm., so that the speed of recording must have been 2.10^5 cm./sec. and 5,000 cm.^{2} area was covered per second. The dimensions of a picture with 400 lines and a side ratio 2 : 3 would be on the other hand 10 × 15 cm., i.e. 150 cm.^{2} if the lines are 0.25 mm. broad. The above-mentioned intensity is thus sufficient to cover the picture area 33 times per second.[16].

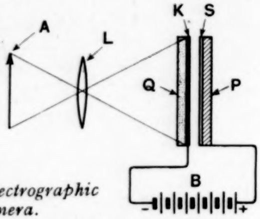
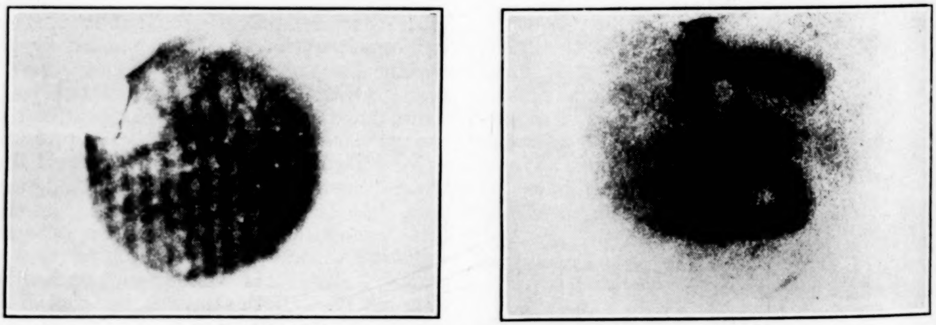


Fig. 8.—*Photo-electrographic electron-camera.*

A further possible application of electrography may be mentioned briefly: the usual public address system could be accompanied by the projection of the enlarged picture of the speaker. Of course, it would be possible to film the speaker and project the film after development. But this would be expensive and necessarily involve a delay, so that television methods had to be tried (see Schröter, ref. 2.) We may substitute electrography in place of photography: The optical image of the speaker is projected upon a preferably transparent photo-cathode and the electrons from this cathode are projected by means of an electron-optical arrangement on an insulating surface. The latter is overdusted and the resulting picture is ready for projection. This process must be repeated continuously—as described above—and would thus solve the problem.[17]

Again the technical difficulty arises, that the process is to be carried out at reduced pressure. To avoid this, it was first tried to realise the process by means of the "photo-electrographic camera" of Fig. 8 in the free atmosphere.

Q is a planparallel quartz plate coated on one side with a transparent magnesium film *K* which acts as photo-cathode. The insulating foil *S* lies on the metal plate anode *P*. *B* is the source of 1,500 volts d.c. The quartz lens *L* projects an image of the object *A* on the photo-cathode *K*. Fig. 9 shows pictures taken with this camera, with an exposure of 10 seconds. (The objects were (*a*) a mesh-work of wires; (*b*) the letters UT.) The pictures were made on paper impregnated with paraffin and were developed with coloured lycopodium powder[18].



(*a*) Fig. 9.—*Pictures taken with the device of Fig.* 8. (*b*)

These pictures are still very primitive. But a comparison of the first, not very satisfactory, oscillograms of 1928 (see publication Ref. 11(f) or even Fig. 7 of the present paper with the extremely sharp oscillograms of Susuki and Tsuji shows that this method could be worked out to a high degree of precision. It is equally certain that electrography itself with its manifold applications—some of which are realised already, others only proposed—is going to play an important part in television.

Summary

Several electrographic methods are described. It is discussed how far and with what chances electrography can be used in television receivers, especially for the projection of large-screen pictures. It is explained that the picture quality (number of lines per picture) essentially depends on the fineness of the developing powder. Presumably 160–240 lines per picture could be attained for 16 pictures per second with a mechanical receiving apparatus. A cathode-ray recording apparatus will yield however more than 400 lines per second. Finally, a related problem is discussed, viz., how to transmit living scenes without any time lag cinematographically. Its fundamental solution is proposed with the aid of the "photo-electrographic electron camera."

References

[1] *Cf.* Fr. Shröter, *Das Fernsehen* (J. Springer, Berlin, 1937) p. 230.

[2] *Telefunken-Zeitung*, 1936, No. 73, p. 5.

[3] (a) *E.T.Z.*, 1935, Vol. 56, No. 35, p. 961; (b) *Zeitschr f. tech. Phys.*, 1935, Vol. 16, No. 12, p. 607; (c) *Zeitschr. f. tech. Phys.*, 1936, Vol. 17, No. 11, p. 487; (d) *Elektrot. u. Masch:bau*, 1937, Vol. 55, No. 11, p. 122. *Cf.* British patent 449824.

[4] With other apparatus for oscillographic recording speeds of 15 m/sec. were realised without any difficulty.

[5] The picture in Fig. 4 does not show clearly enough that the half-tones are due to the modulation of the line width.

[6] The following German plastic materials were used: Plexiglas, Astralon, Vinifol.

[7] It will be shown later that the electrical conditions present no difficulties.

[8] Note particularly the two nearest portraits. There are some very disturbing periodic irregularities on the picture, these are due partly to the primitive mechanism of the apparatus and partly to the irregular velocity which results from turning the drum by a hand-wheel.

[9] Compare Fig. 4, which contains about 200 lines.

[10] BaO coated platinum wires give as much as 50 microamperes/mm.^{2} ionic current in free air, corresponding to 10^6 picture elements per second. We only got, however, as already mentioned, 5 microamperes through an opening of 1 mm.^{2} so that the said number is only 10^5. We cannot account for the difference at present, probably the optimum number of picture elements per second which can be produced in this way will lie between 10^5 and 10^6.

[11] *Cf.* (e) *Zeitschr. für Physik*, 1928, Vol. 47, p. 895; (f) *Zeitschr. für tech. Phys.*, 1928, Vol. 9, p. 451. (g) *Zeitschr. für tech. Phys.*, 1929, Vol. 10, p. 486.

[12] The front of the tube was spherical, owing to the fact that the bulb was one used for incandescent lamps.

[13] *Cf.*: Austrian patent, 115564; D.R.P., 507819; British Patent, 305168; U.S.A. Patent, 1818760.

[14] *Zeitschr. für techn. Phys.*, 1935, Vol. 16, No. 12, p. 607, Fig. 2.

[15] Cathode ray dust oscillogram, by Mr. Susuki and T. Tsuji, *Journ. Inst. Electr. Eng. Japan*, Aug. 1936, Vol. 56, No. 8. Abstract p. 61, Text p. 898.

[16] The authors state that the minimum charge density of records capable of development was 2.10^{-10} coul/cm^2. This corresponds to a ray current of 2 μA on a recorded area of 10,000 cm.^{2}/sec.; twice the value we calculated above.

[17] For the device described above we propose the name "photo-electrographical camera." It represents the combination of the normal "Photoelectronic camera" ("electron telescope" or "photoelectronic image converter") with the electrographic recording methods of the author, the fluorescent screen of the latter being substituted by the insulating screen or film.

The use of an insulating recording screen in electronic devices for television purposes has been described lately by many authors. M. Knoll in *Zeitschr. für tech. Phys.* 1936, Vol. 17, No. 12, p. 604, particularly on page 615, proposed to project an electron-optically produced image on an insulating plate and to scan the latter with a cathode ray as in Zworykin's Ikonoscope. The resulting intermittent voltage could be transmitted for television. Schröter proposed a similar method to be used in television receiving in combination with a Braun-tube having an insulating screen. The received picture was to be recorded simultaneously on the screen of two identical tubes in the form of invisible electrical pictures ("electrical storage of modulations," according to Schröter) and could therefore be scanned and projected in a usual kinescope one after another with a certain delay (e.g. 1/50 second), thus avoiding flickering in the final picture.

I would like to state that a cathode-ray tube having an insulating screen and the principle of electrically stored modulations was described for the first time in the above-mentioned patent specifications (application date in Hungary: February 1, 1928). A method of recording an electrostatic picture on an insulating screen and conserving this "electric picture" was described therein.

[18] A portrait was transmitted from a film with this device, but the picture was too poor to be reproduced.

A Form of Distortion Known as the "Buzz Effect"*

By K. A. Macfadyen, M.Sc.

(Communication from the Research Staff of the M.O. Valve Company, Limited, at the G.E.C. Research Laboratories, Wembley, England)

SUMMARY.—A description of a kind of distortion found in certain samples of the high-slope output pentode is given. The mechanism of the effect is explained and the theory employed to account for radio-interference effects from certain vacuum lamps. Reference is made to earlier papers on the same subject.

In 1934, during the development of the high-conductance output pentode, a new form of valve distortion was noticed. This took the form of a sudden and unexpected buzzing sound superimposed upon certain notes of the music coming from the speaker which the pentode was feeding. The explanation of this effect does not appear to be commonly known, perhaps because the original publication dealing with it† is unlikely to have been widely read in this country.

The attention of the writer was drawn to the phenomenon before the appearance of the paper quoted, and he consequently carried out experiments with a view to explaining and finding how to eliminate this kind of distortion. An account of these experiments may therefore be of interest in spite of the earlier publication, especially in view of the fact that they now furnish an explanation of a recently discovered form of radio-interference,‡ due to the ordinary tungsten lamp.

Perhaps an apology is needed for the name given to the phenomenon. The German writers refer to it as the "S-effekt," but the more expressive (if less elegant) name used here has become too deeply rooted in certain quarters for a change to be made.

Conditions for the Occurrence of the Effect

It was found that the effect took place more readily at frequencies near the bass resonance of the speaker than at other frequencies. An ordinary oscillographic study of the waveform of the anode voltage showed the appearance of an insignificant "pip" on the slopes of each wave when the buzz began. When the I_a-V_a "load-curve" of the valve was formed on the oscillograph-screen, instead of the usual slightly distorted ellipse, the traces shown in Fig. 1 were produced. The curious excrescences appeared simultaneously with the "buzz," and often both would disappear as the valve-bulb heated up. As a rule, these effects would not appear unless the grid-swing were considerable, and never at all if a low impedance preceding circuit were used. The "buzz effect" did not occur with all the samples tried, but

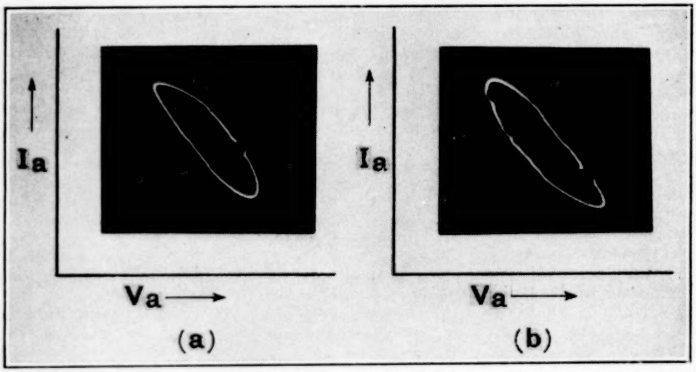


Fig. 1.—*Oscillogram of load-curve, showing "Buzz Effect."*

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* MS. accepted by the Editor, October, 1937.

† Jobst and Sammer, *Telefunken-Röhre*, July, 1934.

‡ G. Lehmann, *L'Onde Electrique* XVI, p. 223 (April, 1937).

there seemed a risk of the trouble being developed in valves during normal service. The way in which these apparently irrelevant observations are explained will be seen later, but the most important fact was that the "buzz" could always be stopped by an earthed tinfoil covering the bulb, and frequently by merely touching the bulb with the finger.

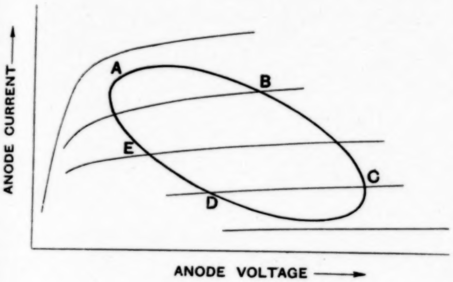

Fig. 2.—*Illustrating static production of discontinuous changes in bulb-potential.*

This directed attention to the true seat of the effect. It was shown (oscillographically) that the potential of the bulb was undergoing sharp and periodic changes of about two or three hundred volts as long as the "buzz" was present. A static experiment, illustrated in Fig. 2, confirmed this observation.

Variations of Bulb-Potential

A suitable valve was set up with potentiometer-controlled anode and grid voltages, as is done when plotting the characteristics. The bulb was covered with tinfoil which was joined to one terminal of an electrostatic voltmeter of high insulation resistance. The other terminal, and also the valve-cathode, were earthed.

The grid and anode voltages were then slowly altered so as to make the representative point on the I_a-V_a characteristics trace out a rough ellipse in the clockwise direction. (Fig. 2). This simulated the behaviour of the valve with an inductive load. At the starting-point A the voltmeter indicated zero. As the part B of the ellipse was traversed a rise of a few volts was shown, but at some point such as C a sudden irreversible rise to about 300 volts or more was registered. This voltage gradually declined at the part D, and when the point E was reached a discontinuous drop from about 100 volts to zero took place.

It will be readily appreciated how these extremely violent changes in bulb-potential can be transferred to the control grid, if there is a sufficient impedance between grid and earth. Bearing in mind the fact that it is customary to insert a stabilising resistance of about 50,000 ohms in series with the grid, and that a sudden change in potential such as we have seen involves very high frequencies, the reader will see that a minute capacitance between bulb and grid will suffice to superimpose an audible overtone on the signal. It should also be remembered that the ear is extremely sensitive to overtones of high frequency ;* far more, in fact, than to the low-order harmonics.

Further experiments, which need not be described here, showed beyond all doubt that the violent changes in bulb-potential were, in fact, responsible for the "buzz." It now remains for us to enquire how the changes are brought about.

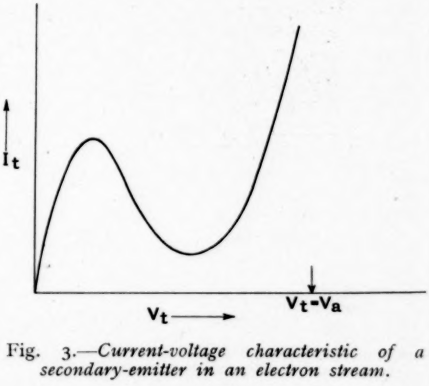

Fig. 3.—*Current-voltage characteristic of a secondary-emitter in an electron stream.*

Mechanism of the Effect—Influence of the Getter

The phenomenon is explainable by considering the emission of secondary electrons by the layer of metallic "getter" inside the bulb. Any secondary-emitting electrode in a stream of electrons exhibits a current-voltage characteristic (I_t vs V_t) of the type shown in Fig. 3. It is assumed that the electrons have been accelerated from rest at earth potential by an anode potential V_a. At low electrode-voltages (V_t) the only effect of increasing this latter voltage is to cause the electrode to gather more electrons per second, but at higher voltages secondary emission makes the current decline. With further rise in V_t, however, the electrode presently assumes the highest potential in the system, and the loss of secondaries is prevented, causing the curve to rise rapidly as $V_t = V_a$ is approached.

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* Harvey Fletcher, *Speech and Hearing* (Macmillan), pp. 167-171.

Also F. H. Brittain (unpublished work).

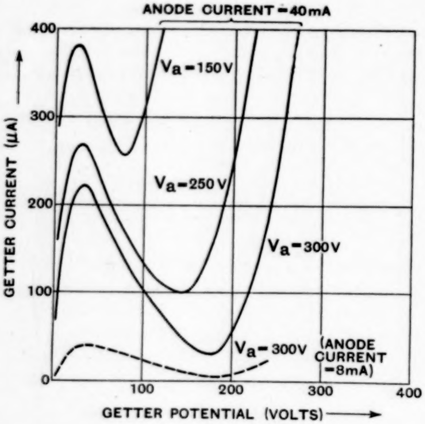

Fig. 4 (*Above*).—*Relation of space-current* versus *voltage for getter on bulb of pentode.*

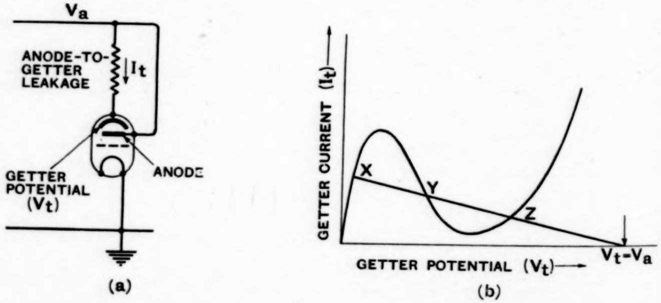

Fig. 5 (*Right*).—*Determination of getter potential by "load-line diagram."*

It is well known that the anode of a screen-grid valve exhibits these effects, but in order to verify that the getter on the bulb of the pentode in question also behaved in this way some sample pentodes were made in which a spring-connection to the getter was provided. Situated as it was in the path of stray electrons from the open ends of the anode, the getter behaved exactly as expected, giving the characteristic shown in Fig. 4. When the anode-current was reduced the "vertical scale" of this curve was reduced, as one would expect, giving a curve like the dotted one in the same figure.

The experimental valves just described enabled the second factor influencing the getter-potential to be investigated, namely, the leakage from the anode to the getter. This proved to be of the order of a megohm.

Let us now investigate the possible potentials which the getter can assume, on the basis of the information just gained. Neglecting † the leakages from screen and grid, and treating the case by the graphical ("load-line") method used for amplifier problems, we obtain the diagram shown in Fig. 5b. The axes represent getter-potential and current respectively, and the curved line is the "characteristic" of the getter, as shown in Fig. 4. Through the point on the potential axis representing the instantaneous anode-potential a straight line is drawn having its slope representative of the anode-to-getter leakage resistance. The intersections, X, Y and Z, of this line with the characteristic curve of the getter give the details of three possible getter-potentials.

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† A modification of the geometrical construction may be introduced to allow for these other leakages. The principles and deductions, however, are unchanged.

It can be shown that the point Y stands for an unstable condition, but that X and Z represent stable states of the getter-potential.

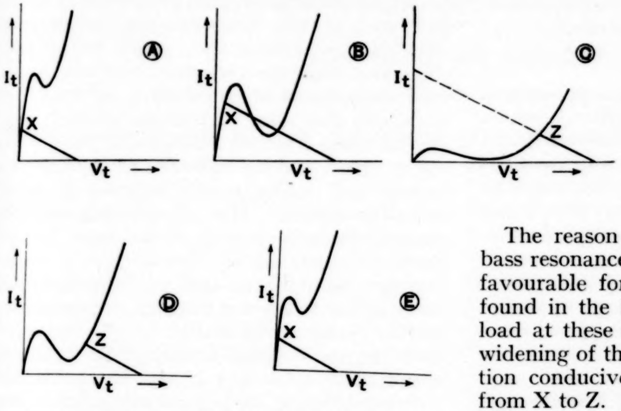

Fig. 6.—*Variation of getter potential during an A.C. cycle.*

Let us follow the behaviour of the getter as the valve amplifies normally over a single a.c. cycle. Starting (as in the experiment of Fig. 2) at A, we find that the graphical solution assumes the form (A) (Fig. 6) appropriate to high anode-current and low anode-voltage. Evidently, since solution Z does not appear, the getter potential must be at X, that is, at a low value. At point B on the ellipse (Fig. 6) the solution (Fig. 6B) indicates little change in the condition of the getter. Certainly, a new possible potential has appeared, but nothing has happened in the meanwhile to cause the getter to change from the "X-state." At point C, however, the rising anode-voltage and falling current have made the "X-state" impossible, so that the getter-potential skips up to Z, some hundreds of volts higher. Figures D and E show what happens on the lower part of the load-ellipse of Fig. 2: a change back to the "X-state" is made, but in this case the skip in potential is very much smaller than the upward jump. In fact, it is often so small (e.g., in Fig. 1a) that its effect on the circuit is negligible. In Fig. 1b, however, the influence of the transition back to the "X-state" can be traced.

We are now in a position to explain the features of the buzz effect described on page 311. Since the presence of the unwanted voltage on the grid is due to electrostatic induction from the getter on the bulb, it will easily be understood how a low-impedance driving circuit will *apparently* suppress the effect. As a matter of fact, it is easily shown that, under these conditions, the getter potential is still flicking violently up and down, hence the emphasis on the word "apparently."

The reason why the frequencies near the bass resonance of the speaker seem especially favourable for producing "buzz" is to be found in the highly inductive nature of the load at these frequencies. This results in a widening of the load-ellipse (Fig. 8), a condition conducive to the largest possible jump from X to Z. Moreover, the return from Z to X is made more certain with this kind of load than with a resistive load. The reader may verify these points with the help of Fig. 6.

The uncertainty of occurrence of the "buzz effect" is due to the fact that rather specialised conditions are necessary for it to happen. The secondary-emission curve may vary over a wide range from one valve to another, and the leakage from anode to getter also. Thus, with a very high-resistance leakage path, the getter is likely to remain permanently in the X-condition. It is not, of course, necessary that the leakage resistances should be as low as 1 megohm; moreover, it has been suggested that, given a small enough getter-current, the capacitance from the anode to the bulb may well provide the stimulus for changing from the X to the Z state and vice versa, even in valves with perfect insulation. This explanation cannot be applied to the case described above, but may reasonably account for many other cases of the phenomenon.

The action of an earthed foil covering in preventing the "buzz effect" is to be explained by the extra leakage from getter to earth. One would expect the added capacitance to result in a more gradual transition from the X to the Z state, but in practice it has been found that the transition to the Z state is prevented altogether by the foil.

A more subtle form of the effect has been detected in certain valves using insulators in close proximity to the electron stream. The reader will now have no difficulty in seeing how this comes about. Fortunately the audible effect is much less marked than in the early experiments described in this paper, in which the bulb entered into the effect.

Prevention

Turning to the question of the prevention of the original form of "buzz effect," which at one time constituted a really serious defect in certain valves, we have now four methods available. One may fix the getter-potential by means of a suitable contact. This is not satisfactory because of the difficulty of maintaining electrical continuity with a layer of getter. Secondly, the getter may be rendered free from secondary emission, e.g., by the use of graphite-coated bulbs. This is the usual system adopted in this country. Thirdly, one can prevent the incidence of secondary electrons on the bulb by means of suitable caps over the open ends of the electrodes. This procedure also reduces grid-anode capacitance, and is consequently adopted in certain cases on account of this added advantage. Its main disadvantage is the cost of production. Lastly, the use of a metal coating on the bulb may be tried. The chief objection to this is that such coatings frequently impede the proper cooling of the valve.*

Explanation of a Form of Interference

The theory of the "buzz effect" given here supplies an explanation of the hitherto obscure form of radio-interference reported by M. Lehmann.† This interference is radiated on rare occasions from tungsten lamps of the vacuum type when fed with A.C. and affects reception in a wide band of frequencies in the region 10 to 100 metres. M. Lehmann's experiments were repeated by Mr. R. F. Proctor in the G.E.C. research laboratories; an approximate harmonic series of trains of waves modulated at 100 cycles per second was detected by means of a short wave receiver in the neighbourhood of the lamp. It should be made clear that the interference is very feeble compared to that given by other common sources, e.g., motors.

Considering the fact that the phenomenon is not shown by gas-filled lamps (in which electronic bombardment of the inside of the bulb is impossible) and bearing in mind other striking points of similarity with the "buzz effect," one is led to the view that the explanation given above is also applicable here. Electrons emitted by the (temporarily) negative end of the filament are accelerated towards the positive end, which they overshoot and strike the very thin layer of evaporated tungsten or tungsten oxide on the inner surface of the bulb. When the filament current is rising from zero the accelerating voltage is small, and we have the state of affairs represented in Fig. 6 (A), with the layer at a low potential. The accelerating voltage rises until the potential of the layer jumps in the manner already described to a value perhaps as much as two or three hundred volts higher. As the current decreases the smaller jump in potential brings the layer back to its original state. This cycle of events is repeated in the next half-cycle due to bombardment at a different point in the bulb. The almost instantaneous charging and discharging of the layer results in an impulsive radiation of very short wavelength (this is decided by the geometry of the lamp) one hundred times a second.

It is, perhaps, hardly necessary to add that the best remedy where this unusual form of interference occurs is to employ gas-filled lamps in those positions where radiation is to be avoided.

In conclusion, the author desires to tender his acknowledgments to the General Electric Company and the Marconiphone Company, on whose behalf the work was done which has led to this publication.

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* Cosgrove, Warren and Benjamin, *J.I.E.E.*, 80, p. 401 (April, 1937).

† *Loc. cit.*

The Industry

NATIONAL Radio & Television Service Company, 155 and 157, Great Portland Street, London, W.1, is now prepared to undertake the construction of amplifiers and similar apparatus to specification.

The Ediswan Loud-Speakerphone inter-communication system is described in a leaflet and booklet issued by The Edison Swan Electric Co., Ltd., 155, Charing Cross Road, London, W.C.2.

Full technical data, characteristic curves and base connections relating to standard American valves (Raytheon) are contained in a well-arranged book available at 2/- post free from Leonard Heys, Faraday House, Henry Street, Blackpool, Lancs.

Electron Transit Time Effects in Multigrid Valves*

Measurements on Short Waves

By M. J. O. Strutt

(Natuurkundig Laboratorium der N. V. Philips' Gloeilampenfabrieken, Eindhoven, Holland)

I. Electron Coupling in Heptode and Octode Frequency Changers

FIG. 1 gives a cross section, in a plane perpendicular to the cathode axis, of an octode frequency changer (type FC4 of Mullard Co.). Under normal operating conditions (see Fig. 1a) grid one (nearest to cathode) has a bias tension of about – 9.5 volts and an oscillator swing of about 11 volts peak value. Grid three is positive (about 90 volts) and grid four (the input signal grid) has a bias of at least –1.5 volts and an input signal. Considering the positive swing period of the oscillator, grid one passes an electron stream, which, after crossing the screen grid three, is partly returned by the reversed electric field between grid three and grid four. A space charge is built up between these grids during the positive oscillator swing period. In the negative oscillator swing period the first grid has a considerable negative tension and passes practically no electrons on to the further tube parts. Hence no space charge exists between the grids three and four during this negative oscillator swing. The space charge varies periodically in the same rhythm as the oscillator voltage on grid one. Now suppose grid four to be connected to the cathode by an impedance, e.g., the tuned input circuit. A voltage of oscillator frequency is induced on this impedance by the periodically varying space charge between grids three and four. This is called " electron coupling." Assuming the electron transit time between grid one and the said space charge to be very small with respect to the period of oscillation of grid one, the induced voltage of oscillator frequency on grid four may be described as due to a one-sided negative capacitance from grid one to grid four. This effect has been dealt with previously (see *Wireless Engineer*, Vol. 14, p. 184) and was studied by Messrs. C. J. Bakker and G. de Vries (*Physica*, Vol. 1, p. 1045). The negative capacitance from grid one to grid four varies between – 2 and – 0.6 $\mu\mu$F. for oscillator alternating voltages between 2 and 9 volts (eff. value) on grid one with the FC4 at 200 m. wavelength.

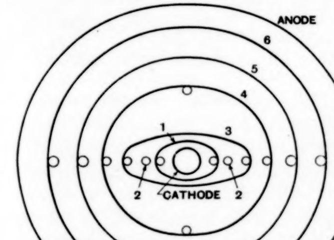

Fig. 1.—*Cross section to scale of octode frequency changer valve type FC_4 (Mullard). The oscillator part consists of the cathode, grid one and grid two (oscillator anode). Grids three and five are interconnected and serve as screens. Grid four is the input signal grid. Grid six is a suppressor.*

II. Transit Time of Electron Coupling

On short waves, e.g. at 30 or at 20 m wavelength, the transit time of electrons from grid one to the space charge region between grids three and four is no longer negligible with respect to the period of oscillation. This effect may be measured in a simple way. A diode voltmeter (see *Wireless Engineer*, Vol. 14, p. 478) is connected across the input signal circuit. Omitting the input signal, this voltmeter indicates the induced voltage of oscillator

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*MS. accepted by the Editor, November 1937.

frequency on the input circuit. Of course, in the short wave region, elaborate shielding precautions are necessary to prevent spurious voltages, induced on this circuit in an unknown way (see *Wireless Engineer,* Vol. 14, p. 186).

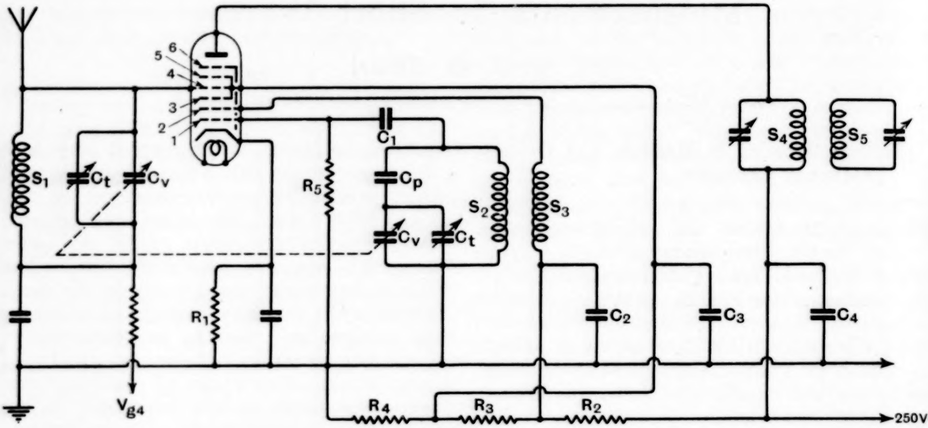

Fig. 1a.—*Connections of an octode frequency changer valve.* S_1, C_t, C_v, *are parts of the tuned input circuit.* V_{g4} *is the negative bias (A.V.C.) of the input grid.* R_1, *250-ohm bias resistance.* R_2, *2,000-ohm potentiometer.* R_3, *700-ohm potentiometer.* R_4, *6,500-ohm. potentiometer.* R_5, *leakage resistance of oscillator of 50 000 ohms.* C_1, *capacitance of 200 μμF.* C_p, C_v, C_t, S_2, S_3 *are parts of the oscillator circuit.* S_4, S_5 *are parts of the intermediate frequency transformer.* C_2, C_3, C_4 *are block condensers.*

A small variable condenser of some μμF max. value and about 0.3 μμF minimum value is connected between grid one and grid four. By properly setting this condenser, on a wavelength of 200 m, the induced voltage on the input signal circuit can be made to disappear almost completely. This means that the electron coupling may rather accurately be represented by a negative one-side capacitance from grid one to grid four at this frequency. The small residual induced voltage on the input circuit at the best setting of the neutralising condenser connected between grid one and grid four indicates, that already at 200 m wavelength a small transit time effect is present. Let us consider the effect of this transit time on the negative capacitance $-C_{14}$ of the valve between grid one and grid four. In Fig. 2 a vectorial admittance diagram of the different quantities is drawn. If no transit time effect occurs, the negative admittance in the valve from grid one to grid four is represented by $-j\omega C_{14}$ and may be completely neutralised by the admittance $j\omega C_n$ due to the neutralising condenser between these grids. If, however, transit time occurs, the admittance A_{14} in the valve from grid one to grid four lags behind the admittance $-j\omega C_{14}$ by a phase angle a (see Fig. 2).

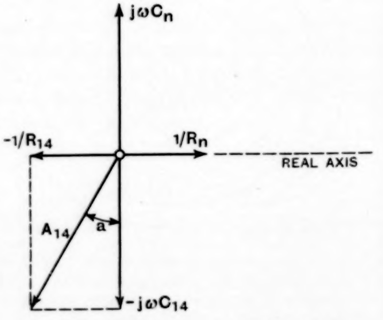

Fig. 2.—*Vectorial diagram of admittances between grid one and grid four.*

This admittance A_{14} has a component $-1/R_{14}$ and a component $-j\omega C_{14}$ and may hence be compensated by a conductivitance $1/R_n$ in parallel with the neutralising condenser C_n. The phase angle a is given by:

$$\tan a = 1/R_{14}\omega C_{14}$$

If the transit time of electrons from grid one to the space charge region between grids three and four is t (secs), a will be equal to ωt, where ω is 2π times the frequency in c/s. We can thus measure this transit time by determining the values of R_n and of C_n.

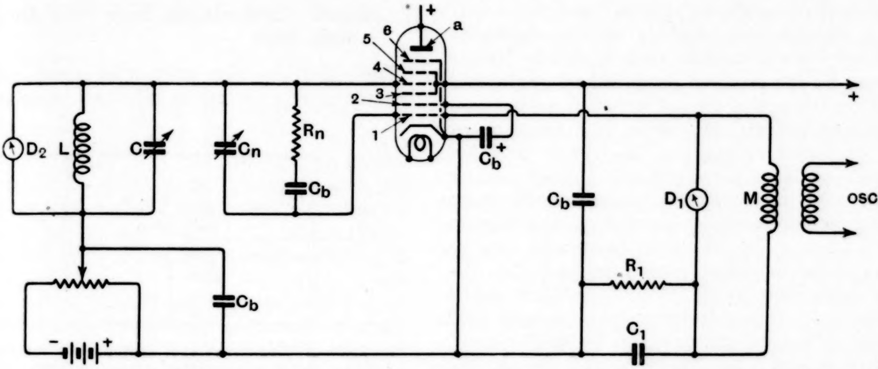

Fig. 3.—*Connections of apparatus for measuring admittance between grid one and grid four. D_1 and D_2 are diode voltmeters (acorn type diodes). L, C parts of circuit tuned to the oscillator frequency. C_b are block condensers, 20 000 $\mu\mu F$. C_n and R_n are neutralising capacitance and neutralising resistance. R_1, leakage resistance of 50 000 ohms. C_1, capacitance, 200 $\mu\mu F$. M, coil of a few turns, coupled to oscillator.*

III. Measurements of Transit Time of Electron Coupling

No continuously variable resistances of very small dimensions, necessary for short wave measurements were available. Therefore, fixed resistances were connected between grids one and four, in series with a mica blocking condenser of 20 000 $\mu\mu$F, which was necessary because of the different direct voltages on grids one and four. The scheme is given in Fig. 3. The oscillator voltage was put between grid one and cathode, using a bypassed bias resistor R_1 of 50 000 ohms. The coupling coil M has only a few turns. The oscillator voltage is measured with the diode voltmeter D_1 and is kept constant during the measurements. A second diode voltmeter D_2 is used to measure the voltage across the circuit CL, which is tuned to the oscillator frequency. With every value of R_n, the variable neutralising condenser C_n is set thus that D_2 shows a minimum value of the voltage on the circuit CL. The diodes used in the voltmeters are acorn valves. The absolute calibrations of these voltmeters, taken at 500 c/s, hold good to about 60 Mc/s (see *Wireless Engineer*, Vol. 14, p. 478-488). The resistances were measured separately on the wavelengths used, as to their actual short wave resistive and capacitive impedance components. In the following table some impedance values of such resistances are shown by way of examples :

TABLE I

Rated value of Resistance.	Measured D.C. Resistance	Measured resistance at 31 m Wavelength.
Ohms.	Ohms.	Ohms.
40 000	44 000	44 600
80 000	81 800	70 000
125 000	119 000	60 500
200 000	215 000	131 000
400 000	571 000	236 000
800 000	766 000	398 000

These resistances were measured on short waves by connecting them parallel to a circuit, using apparatus, described in a previous article (see *Wireless Engineer*, Vol. 14, p. 478). Their parallel capacitance was about 0.5 $\mu\mu$F. In Fig. 4 the induced voltages on the grid four circuit are plotted as a function of the resistances R_n with the neutralising condenser C_n set according to a minimum value of the induced voltage for every resistance value. The resulting values of C_{14} and R_{14} are for a wavelength of 31 m at 9 volts eff. oscillator tension $R_{14} = -116\,000$ ohms ; $C_{14} = -0.75\ \mu\mu$F, $\tan a = 0.190$.

It is reasonable, to assume, that $\tan a$ will only depend very slightly on the oscillator voltage, as the transit time is chiefly determined by the positive potential on grid three and by the space charge between grids three and four (which, of course, is a function of the oscillator voltage). The transit time t is found to be 3.1×10^{-9} secs. This transit time may be calculated independently from the dimensions of Fig. 1 and from the tension on grid 3. The distance from grid one to grid three is about 0.55 mm and the distance between grid three and grid four about 3.25 mm. The electrons pass across grid three with a velocity v given by $mv^2 = 2\,eV$, where m and e are the mass and the electric charge of an electron and V is the tension of grid three, being 70 volts in our measurements. This velocity is slowed down to zero between grid three and grid four. Assuming the mean velocity to be $v/2$ in this region, and also between grid one and grid three, the transit time from grid one to grid four is given by $2d/v$, where d is the distance. Before grid four the electrons build up the space charge in the positive oscillator swing period. With a value of $e/m = 17.6 \times 10^{14}$ (cm^2 sec.$^{-2}$ volts^{-1}) in practical units one obtains :

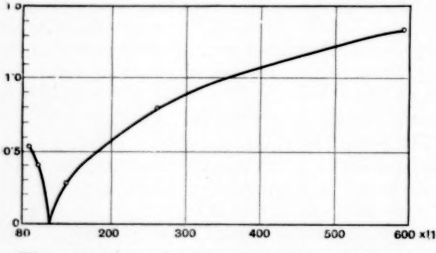

Fig. 4.—*Curve for determining the neutralising resistance R_n of Fig. 3. Vertical : Volts on diode voltmeter D_2 of Fig. 3. Horizontal : resistance values R_n of Fig. 3 (ohms).*

$$t = \frac{2d}{\left(\frac{2e}{m}\right)(V)^{\frac{1}{2}}} = \frac{2 \times 0.37}{(35.2 \times 10^{14} \times 70)^{\frac{1}{2}}} = 2.1 \times 10^{-9} \text{ sec.}$$

We see that the calculated value of the transit time is of the same order of magnitude as the value of the measured transit time. Electrons which turn several times round the wires of grid 3 may cause this deviation.

IV. Mutual Conductance from Grid One to Grid Two

The electrons are prevented from going directly from grid one to grid two (consisting of two rods, see Fig. 1) by the supporting rods of grid one. They are first drawn through grid three and the electrons, which return from the space charge region before grid four, are partly drawn to grid two. If this picture is correct, a considerable phase angle of the mutual conductance from grid one to grid two must exist. If this mutual conductance has on short waves the complex value $S = S_1 - jS_2$, then $\tan \omega t_1 = S_2/S_1$, where t_1 is approximately the transit time from grid one to grid two. This transit time t_1 will under similar circumstances (same value of the tension on grid three) be approximately twice the transit time t, calculated above between grid one and grid four.

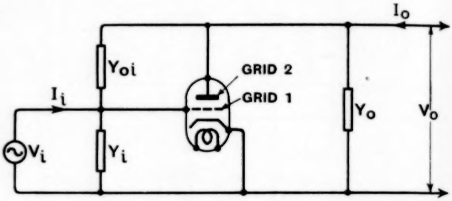

Fig. 5.—*Equivalent circuit diagram for measuring the complex transconductance between grid one and grid two of octode.*

In measuring the phase angle of the mutual conductance from grid one to grid two, a method due to F. B. Llewellyn (*Proc. Inst. Rad. Eng.*, Vol. 22, 1934, p. 947) was used with slight modifications. The scheme is shown in Fig. 5, where the grid is grid one and the anode represents grid two of an octode. Let S be the mutual conductance (complex), Y_i an admittance consisting of a small resistance (of 10 ohms), Y_0 an admittance consisting of a small inductance (of 0.050×10^{-6} Henry), Y_{0i} an admittance consisting of a parallel circuit of an inductance, a variable capacitance and a variable resistance, V_i the input alternating voltage (about 0.1V), V_0 the output alternating voltage, I_i the input A.C., I_0 the output A.C. Then :

$$I_i = (Y_i + Y_{0i})V_i - Y_{0i}V_0 ;$$
$$I_0 = (S - Y_{0i})V_i + (Y_0 + Y_{0i})V_0.$$

As I_0 is zero :

$$V_0 = -\frac{S - Y_{0i}}{Y_0 + Y_{0i}} V_i.$$

The admittance Y_{0i} is adjusted to make V_0 zero (this voltage is measured with an amplifier and a diode voltmeter). Obviously we have in this case : $S = Y_{0i}$, which determines the slope S, as the admittance Y_{0i} is known.

The actual measuring apparatus is rather elaborate and completely screened. At 9.1 m wavelength for a tension of 70 volts on grid 3, 100 volts on grid two, $-$ 1 volt on grid one and $-$ 1.5 volts on grid four, the slope was found to be :

$S = |S| e^{-i\phi}$, with $|S| = 1.66$ ma/volts and $\phi = 58$ degrees.

Taking a transit time of $t_1 = 4.2 \times 10^{-9}$ secs, $\omega t_1 = 2.06 \times 10^8 . 4.2 \times 10^{-9} = 0.87$ or about 50 degrees. As our calculation of t_1 is rather rough, the agreement might be called sufficient. Some electrons will oscillate several times about grid three and thus cause an increase of the phase angle of S.

If the above picture of the electron paths is right, the transit time t_1 should be proportional to $(V_3)^{-\frac{1}{2}}$, where V_3 is the tension of grid three. This should also hold for the phase angle ϕ being equal to ωt_1. Some measurements gave (9.1 m wavelength) :

V_3 (Volts)	$\phi = \omega t_1$ (degrees)
40	71.3
50	66.1
60	62.5
70	58.5
80	54.5

Here the tensions of grids one, four and two were $-$ 1, $-$ 1.5 and 90 volts.

The proportionality of ϕ to $(V_3)^{-\frac{1}{2}}$ is approximately satisfied by these measured values.

If the tension of grid four is made more negative, the returning point of the electrons will lie nearer to grid three and the transit time t_1 will be decreased. This was also checked by some measurements (9.1 m wavelength).

V_4 (volts)	$\phi = \omega t_1$ (degrees)
0	60.1
$-$ 2	59.7
$-$ 5	47.5
$-$ 10	45.5
$-$ 20	42.5

The tensions of grids one, two and three were : $-$ 1, 90 and 70 volts.

An elaborate account of further measurements of the complex mutual conductance in multigrid valves on short waves will be available for publication at a future date.

A new type of octode, called "four beam octode," was invented by the author, in which electrons pass directly from the cathode through grid 1 to the oscillator anode, avoiding the large phase angles measured above for the *F.C.*4. Furthermore, in this new four beam octode (Mullard type *E.K.*3) screens prevent electrons, on arriving at grid 4, from returning to the oscillator space, thus avoiding frequency drift by biasing grid 4 (see *Wireless Engineer*, Vol. 14, 1937, p. 187). The valve *E.K.*3 contains a resistance in series with a small condenser between grid 1 and grid 4 in order to neutralise electron coupling as was described above.

V. Transit-time Current

An effect was described previously (*Wireless Engineer*, Vol. 14, 1937, p. 190), by which electrons could land on a negative grid (e.g. $-$ 3 Volts) in a hexode frequency changer. This electron current was called transit time current and will be dealt with more elaborately here. The simplest valve, in which it may occur, is a tetrode (Fig. 6). The anode has a negative tension with respect to the cathode of some volts, and, moreover, an alternating voltage of some volts and

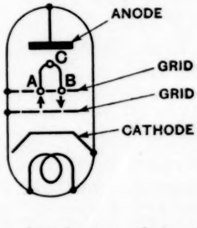

Fig. 6.—*Diagram of electron path between grid two and anode of a tetrode valve, causing a transit time d.c. to grid one.*

of a short wavelength (e.g. 10 m). Grid two has a positive tension V_2 of about 100 volts and grid one has a negative tension of some volts. Electrons are drawn from the cathode region through grid one by the positive tension of grid two and enter the space between grid two and the anode with a velocity v given by $mv^2 = 2\,eV_2$. In this space their velocity is slowed down to zero and the electrons travel again towards and through grid two, coming again in the vicinity of grid one. If no alternating voltage is applied to the anode, no electrons can reach grid one. It is easy to show that an alternating voltage of high frequency on the anode can accelerate some electrons so much that they are enabled to reach grid one in spite of its negative tension. In Fig. 7 the alternating anode voltage is shown as a function of the time. Assume an electron, entering the grid two — anode space in the point *A* of Fig. 6 at the moment *A* of Fig. 7. This electron will be less slowed down during the period *A–C* (Fig. 6 and Fig. 7) than without alternating volts on the anode. Hence the point *C* of Fig 6 will lie nearer to the anode than would have been the case without alternating voltage on the anode. During the period *C–B* (Figs 6 and 7) the electron will be more and longer accelerated than without alternating volts on the anode. Hence it will leave the grid 2 — anode space at *B* with a greater velocity than at the point *A*, when entering this space. This excess velocity will enable it, under favourable circumstances to reach grid one. The excess energy of the electron under consideration is of the order of eE_a, where E_a is the amplitude of the anode alternating voltage. Hence it may reach grid one, if its negative tension is also of the order of E_a, but not much greater. By considering electrons, entering the grid two — anode space at other moments of the curve of Fig. 7 it will be seen, that the case considered above, is extremely favourable for obtaining excess energy in this space. It may be shown mathematically that the transit time current to grid one is proportional to $f^2 E_a^2 d^2/V_2$, where f is the frequency, E_a the anode voltage amplitude, d the distance between grid two and the anode and V_2 the tension of grid two. This holds for small voltages E_a, compared with V_2 and for electrons, travelling only once on the path considered above. In reality, some electrons will travel this path several times, thereby gathering more excess energy, if conditions are favourable.

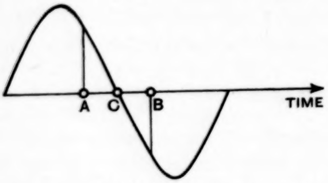

Fig. 7.—*Alternating volts on anode of Fig. 6 (vertical) against time (horizontal).*

VI. Transit-time Detector

Obviously the valve of Fig. 6 may be considered as a means of obtaining D.C. out of A.C., which is commonly called a detector. Using the circuit of Fig. 8, with a commercial tetrode, the current i was measured as a function of E_a (Fig. 9). A normal detection curve, first quadratic and then for larger voltages E_a becoming linear, results. Thus a new type of detection, which might be called transit time detection, is established.

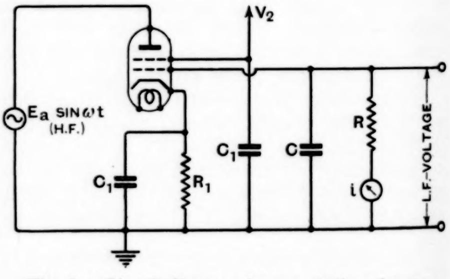

Fig. 8.—*Circuit diagram for transit time detector. C_1 are block condensers, 0,5 μF. R_1, bias resistance, about 300 ohms. C, condenser of 100 $\mu\mu F$. R, leakage resistance of about 1 megohm.*

This transit time detector may in one tube be combined with a low frequency amplifier. The condenser C_1 between grid two and earth in Fig. 8 should be of the same magnitude as the condenser C in this case and the screen grid tension must be supplied in series with a resistance of about 0.5 megohm. The screen grid serves as anode of the triode: cathode, grid one, grid two and the amplified L.F. voltage is generated across the resistance in series with the grid two tension supply.

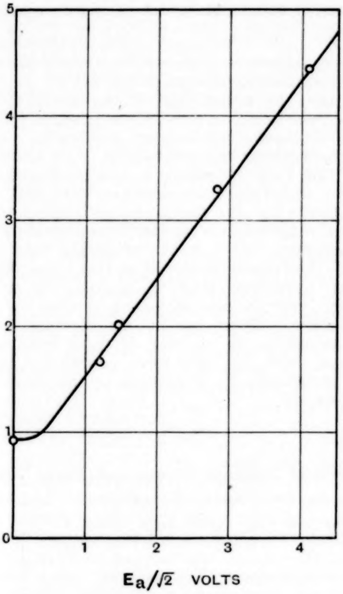

Fig. 9.—*Detected volts (vertical), being current i multiplied by R of Fig. 8 as a function of the H.F. voltage (eff. volts) for a tetrode valve type RCA 35 with 60 volts on the screen. Wavelength 10 m.*

Just as a diode may also be used as a frequency changer (see *Wireless Engineer*, Vol. 13, 1936, p. 73–80), the same holds for this transit time detector. Several schemes of connections can be devised for this end, which, however, would take too much space to discuss here.

VII. Summary

Section I explains that the electron coupling in octode frequency changers may be represented by a one-side negative capacitance from the oscillator grid (grid nearest to cathode) to the input grid (grid four), if no transit time of the electrons, travelling from grid one to grid four has to be taken into account. Section II deals with this transit time and shows that a one-side negative resistance must be considered in parallel to the one-side negative capacitance as a result of electron transit time. By measuring this negative resistance and negative capacitance, the said transit time may be estimated. Section III deals with these measurements at 31 m wavelength and gives a comparison of the measured transit time effect with the roughly calculated transit time, which coincide very nearly. Section IV deals with measurements of slope (trans-conductance) from the oscillator grid to the oscillator anode of an octode and shows that a great phase angle (some 60 degrees) occurs in this slope at 9 m wavelength due to the transit time of electrons. The calculated times are shown to be in sufficient concordance with the measured values. In Section V the transit time current is dealt with, being a small D.C. flowing to grid one, having a negative bias of some volts, of a tetrode, the anode of which is connected to a short wave voltage supply in addition to a negative bias, whereas the screen grid is positive. Section VI gives an application of this transit time current effect to a new type of detection.

The author expresses his appreciation for the able assistance of Dr. K. S. Knol and Dr. A. van der Ziel in obtaining some of the above data.

Notation for Piezo-Electric Quartz

A pamphlet of 10 pages and 4 Figures. Published by H.M. Stationery Office. Price 3d. (Postage extra).

At the request of the Department of Scientific and Industrial Research, a report on this subject was drawn up by the N.P.L., the Post Office, the Marconi Co., and Standard Telephones and Cables, Ltd. This report was circulated to scientists and institutions throughout the world. The present pamphlet is based on the original report, with due consideration of the comments received.

In view of the large use now made of quartz plates, it is very desirable that a standard method of defining the various planes and axes should be adopted. The pamphlet sets out very clearly a complete system of nomenclature, drawn up after a careful study of the literature of the subject.

Occasionally alternative notations are referred to and their disadvantages pointed out. The scope of the pamphlet is indicated by the section headings: introduction, axial notation, dimensions of vibrators, types of vibration, elastic properties, piezo-electric properties, crystal faces, types of cut, twinning, bibliography.

It is to be sincerely hoped that everyone concerned with the subject will obtain the pamphlet and employ no other notation than that so carefully set out. G.W.O.H.

Correspondence

Letters of technical interest are always welcome. In publishing such communications the Editors do not necessarily endorse any technical or general statements which they may contain

Background Noise

To the Editor, The Wireless Engineer.

SIR,—I write in connection with Mr. D. A Bell's letter published in your April issue. It is there stated that I have used certain results to condemn the whole thermal hypothesis of valve fluctuations. This statement is not in accord with my views. My results were interpreted as rebutting the thermal hypothesis as it then stood; the rebuttal does not necessarily apply to the modified thermal hypothesis now proposed.

Llewellyn's original hypothesis held that a space charge limited valve of any type generated a fluctuation current,

$$\bar{i}^2 = \frac{4kT}{\rho}\,df,$$

where T was taken as T_c, the absolute temperature of the cathode. The experiments of Pearson and myself showed that with diodes $T_c/2$ was a more suitable value, and this modification to the hypothesis was made, but without convincing theoretical justification. My later experiments with triodes showed that then T was many times T_c. Attempts had been made to explain such results as due to the coexistence of the (Llewellyn) thermal fluctuation and a residual shot effect due to incomplete space charge.

My experiments showed that such an attempt led to the conclusion that the thermal contribution was negligible compared with the (supposedly residual) shot contribution. It was therefore argued that valve noise was due to shot effect and that thermal agitation fluctuations in the anode stream were non-existent or negligible. According to Bell, however, the new thermal hypothesis is limited to diode valves, on the ground that space charge limitation is necessarily incomplete in any other type. The above line of argument, involving measurements with triodes, is no longer admissible as a refutation of the thermal hypothesis: it has, however, served its purpose, for the hypothesis it condemned is now rejected.

As to the probable validity of this new limited thermal hypothesis, the writer is undecided. Experiment does not confirm it, nor does it confirm any other hypothesis so far propounded. On the theoretical side the decision must rest with the pure physicist rather than the engineer.

As to its technological suitability as a method of interpreting observed results, the writer has very marked views. For if the alternative shot interpretation be used, self-consistent results with a given multi-electrode valve can be obtained when that valve is used as a diode, triode, tetrode and pentode. Since the temperature of the anode stream is at present indeterminate in all but the diode connection, and is vastly different for each connection, thermal interpretation is meaningless: it is also technologically inconvenient since the thermal equation does not lend itself so easily to the computation of signal/noise ratio.

It may be noted that if the modified thermal hypothesis is to be proved experimentally the agreement obtained must be very good to be convincing, for an effective temperature of $T_c/2$ exists in the retarding field according to the simple shot hypothesis. Approximate support for the thermal hypothesis in the space charge régime may thus merely represent a shot fluctuation tending towards its necessary value in the retarding field region.

For the reasons outlined in this letter, the writer would have preferred to express the results of Messrs. Percival and Horwood in terms of the shot expression. Their use of the thermal interpretation, however, in no way detracts from the value of their work, for they have quoted the equivalent grid resistances R_n and these are the same on both hypotheses.

F. C. WILLIAMS,
Electrotechnics Department,
The University of Manchester.

Critical Distance Valves and Beam Tetrodes

To the Editor, The Wireless Engineer.

SIR,—In the April 1938 issue of *The Wireless Engineer*, there appears a letter written by Mr. J. H. Owen Harries on the subject of Critical Distance Valves and Beam Tetrodes, in which reference is made to a recent paper of ours*. We trust that we have misunderstood Mr. Harries' remarks, but it appears to us that he believes our interest in this subject to be other than purely technical. Since this is not the case, we shall confine our remarks to the technical aspect of Section (9) of his letter.

Mr. Harries criticises our "endeavour to explain the operation of beam tetrodes in terms of the usual space-charge effect," and then states that "certain properties of secondary radiation are studiously ignored."

It may be pointed out that our discussion of the beam tetrode is presented merely as an example of the applicability of the general theory which was the principal subject of the paper. In considering the operation of such tubes, it would appear to us that the following factors must be considered in a complete analysis of the problem: (1) the space-charge effect of the primary electron stream upon the potential distribution between accelerator grid and anode, (2) the distribution of forward velocities of the electrons, including both temperature distribution and the effects of deflection by intermediate electrodes, and (3) the space-charge effect of the secondary electrons emitted from the anode and the accelerator grid. In our paper we mention these factors and others. It is true that in our analysis only the space-charge effects of the primary electron stream are considered quantitatively. It is our belief based on theoretical considerations and experimental results that the other factors are not of primary importance in determining the operation of the tubes which we discussed. Certainly a quantitative treatment of all factors influencing the operation of beam tetrodes would be highly desirable.

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* "Effects of Space Charge in the Grid Anode Region of Vacuum Tubes." Bernard Salzberg and A. V. Haeff, *RCA Review*, Vol. 2, No. 3, pp. 336–374 (January, 1938).

We shall await with great interest the promised publication of Mr. Harries' explanation of the mechanism of the critical distance.

BERNARD SALZBERG.
A. V. HAEFF.
R.C.A. Manufacturing Co. Inc.
Harrison, N.J.

Short-wave Transmitters with Spherical Circuits

To the Editor, The Wireless Engineer.

SIR,—I read with much interest the Editorial by Prof. G. W. O. Howe in the March issue of your journal dealing with Hollmann's experiments on Kolster's circuits, and I write as I feel sure that you must be unaware of the experiments which have been carried out on the same lines in this country by three British Radio Amateurs, namely, G5VY, G6JI and G8SK during the past two years.

I was privileged to be among those present at a meeting of the Walthamstow and District Radio Society on July 4th, 1936, when Mr. Vickery (G5VY) gave a lecture-demonstration of what he described as "A High Q transmitter," using two spun aluminium "hats" for inductance and capacitance on a wavelength of 56 Mc/s based on the Kolster theory.

Since then three of these transmitters have been constructed for 5 metres and two for 2½ metres all giving excellent results—ordinary valves (without de-capping) being used as oscillators—and the following is a brief outline of some of the results obtained with them.

Efficiencies of some 70 per cent. on 5 metres with inputs of from 6 to 10 watts. The 5-metre oscillators have been used to drive a push-pull P.A. stage, and the resultant signals are as stable as crystal-controlled transmitters on lower frequencies. The 2½-metre oscillator has been modulated and is regularly received on schedule at a distance of 6½ miles on a super-het. receiver without the use of special antennae at either end.

The photograph shows two of Mr. Vickery's transmitters in which the spun aluminium "hats" are plainly visible; the transmitter on the right operates at 56 Mc/s, that on the left at 112 Mc/s. The first of the series of transmitters utilising Kolster circuits was made early in 1935.

L. J. FITZGERALD.
London, E.11.

Deflection Valves for Ultra Short and Decimetre Waves

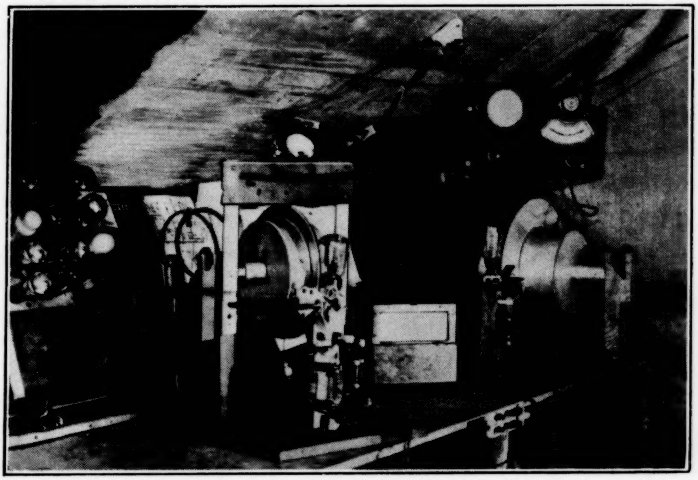
To the Editor, The Wireless Engineer.

SIR,—Recently a good deal of publicity has been given to the idea of using "deflection valves" which employ a beam of electrons which is deflected with the object of producing extremely high frequency oscillations. Mr. F. M. Colebrook's article in your issue for April last, pages 198 to 201, entitled "Ultra Short and Decimetre Waves," expresses the viewpoint of the Radio Research Board with regard to this matter.

The prior history of this technique is not well known and the following notes may be of interest to your readers.

1. One of the earliest types of electron discharge tube is the cathode-ray oscillograph. The history of the development of this device is given in a paper by McGregor Morris and Mines (*Journ. I.E.E.*, Nov. 1925, Vol. 63, No. 347, pp. 1056 to 1107).

2. Parallel with the development of the ordinary short stream 3/2 law (control grid) valve (based on the work of Fleming, de Forest and Langmuir), another type of amplifier and frequency multiplying valve was suggested. The first inventor appears to be Robert von Lieben. He described, in German Patent No. 179807, dated 1906, a valve employing a jet of cathode rays (which he speaks of as being similar to that used by Wehnelt for other purposes in 1905) which was deflectable over two hollow cylindrical anodes. The jet current to one of these cylinders was used to energise an output load. This valve appears to be one of the earliest types



of thermionic relay, and is clearly based on cathode-ray oscillograph technique.

3. Very shortly afterwards, in 1906, Dieckmann and Glage in German Patent No. 184710 described improved anodes over which the jet was caused to move. Their object was to obtain " proportional amplification," i.e. distortionless amplification. They connected their output electrodes in a push-pull manner which was similar to that illustrated in Fig. 1 of Mr. Colebrook's article.

4. In 1913, Rene Zei, in British Patent No. 18438, described a similar idea. He moved his cathode mechanically.

5. Nasarischwily (*Ann der Physik*, 1921, Vol. 64, p. 759) made a deflection valve which he described as being similar to the tube used as an oscillograph by Samson in 1918 (see McGregor Morris and Mines's paper, Figs, 31, 32 and 33). By employing an output electrode upon which the jet impinges and which is electrically coupled back to his deflecting plates, Nasarischwily produced an oscillator capable of generating high frequencies.

A further development of the idea is to cause the jet to move over a number of contacts or anodes for every cycle of the input deflecting force. A frequency multiplier is thereby produced. Such an arrangement was described by Van der Bijl in 1918 (U.S. Patent No. 1613626).

6. Dieckmann and Gebbert in 1921 (German Patent 375808) tackled the problem of obtaining an appreciable current in a long and deflectable jet of electrons. They reduced the length of their jet to get a larger current. As they pointed out in two papers in *Jahrbuch der drahtlosen Telegraphie* (1922, Vol. 19, p. 194, and 1923, Vol. 22, p. 107), their tube did not compete with the ordinary type of valve because the current to voltage ratio was too low, as, also, was the sensitivity to deflection.

7. A study of these publications shows very well the real difficulty of the deflection valve, which is not specifically mentioned in Mr. Colebrook's paper. If the jet is made long, by the use of an electron gun in a manner similar to many of the attempts mentioned above, and to the tube used by Mr. Colebrook, the ratio of current to voltage is far too low to compete in efficiency with ordinary control grid valves. The valve described by Mr. Colebrook will require an anode load of the order of at least four megohms, which is quite an impracticable value for a power handling device. The total DC power handled by the jet is only one watt. If the jet in a deflection valve is made shorter the current to voltage ratio is still too low to compete with the control grid valve, and sensitivity to deflection is greatly reduced.

8. Another deflection valve in which, like Dieckmann and Gebbert's tube, sensitivity to deflection has been sacrificed in an endeavour to obtain a reasonable current to voltage ratio, was described by Strobel in U.S. Patent No. 1757345 (1928).

9. Other publications are as follows :—

U.S.	Patent	No.	1720724
,,	,,	,,	1659636
,,	,,	,,	1763309
,,	,,	,,	1836569
German	..	,,	450040

Experiments with an Amplifying Valve on the Transverse Field Principle, H. Alfven, *Zeitschr. f. Hochf. Tech.*, July 1931, Vol. 38, pp. 27–29.

In the last year or two a large number of British and other patents have been granted dealing with this type of valve, but none of these appears to add anything fundamental to the work of the earlier investigators.

10. British Patent No. 313882 of 1930 to the Associated Telephone and Telegraph Company, states in the beginning that it is intended to reduce the length of the jet (despite the sacrifice of sensitivity) in an endeavour to get a better current to voltage ratio. The attempt was a failure. A valve made up in accordance with the drawings to this patent gives a power output of only about 0.000087 watt into a load of 8,700 ohms, and it requires an H.T. supply of the order of 500 volts to get a total jet current of only 4 mA. I also built up a model of Dieckmann and Gebbert's valve (item 6) and the maximum power output obtained was only 0.000000262 watt into a load of 60,000 ohms across push-pull connected targets.

11. During 1928 and 1929 I explored the possibilities of the deflection valve when endeavouring to improve the known methods of generating ultra-high frequencies for the purposes of television. I obtained two British Patents, Nos. 328680 and 366053. The specifications to those patents contained what now appears to be a very complete analysis of the deflection valve idea ; but the difficulty of a jet current to voltage ratio still existed and this difficulty was not overcome despite protracted work on my part at that time in conjunction with the General Electric Research Laboratories at Wembley.

12. Afterwards, a successful solution of the difficulty of the current to voltage ratio was found as a result of some research which was first published in my British Patents Nos. 380429 and 385968 (1931). It was also described some years later in *The Wireless Engineer*, April 1936, Vol. 13, No. 151, pp. 190 to 199.

13. A further problem of the deflection valve is the fact that when the jet moves from one contact to another (for example, from one bucket to another in Mr. Colebrook's Fig. 1) a cross field is produced, due to the voltage drop in the load, which tends to counteract the deflection. This may be overcome by employing an electrode having mesh covered openings in front of a target in the manner shown in Figs. 17, 18 and 23 of the above-mentioned British Patent 380429.

14. Mr. Colebrook describes an idea of utilising secondary radiation to increase the current change produced by deflecting the jet. This was first described by Hopkin in U.S. Patent 1920863 (1932).

15. In the laboratory of this company, we have recently succeeded in producing deflection valves capable of operating on quite high frequencies, and of delivering appreciable powers, by utilising the technique described in British Patent 380429. It is hoped to publish this work before very long. I should be very interested to hear of any work by other investigators in this direction, and of any corrections or additions to this necessarily brief history.

J. H. Owen Harries,
Director, Harries Thermionics Ltd.

London, S.W.19.

Abstracts and References

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For the information of new readers it is pointed out that the length of an abstract is generally no indication of the importance of the work concerned. An important paper in English, in a journal likely to be readily accessible, may be dealt with by a square-bracketed addition to the title, while a paper of similar importance in German or Russian may be given a long abstract. In addition to these factors of difficulty of language and accessibility, the nature of the work has, of course, a great influence on the useful length of its abstract.

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PROPAGATION OF WAVES

2174. THEORY OF CYLINDRICAL DIELECTRIC CABLES [" Wave Guides "] AND RELATIONS WITH THE THEORY OF COAXIAL CABLES.—A. G. Clavier. (*Bull. de la Soc. franç. des Élec.*, April 1938, Vol. 8, No. 88, pp. 355–388.)
It is suggested that when the technique relating to " hyperfrequencies " has been improved, wave guides may be used for television, etc., instead of coaxial cables. The type of guide nearest to the coaxial cable is here studied; it is a single cylindrical conductor enclosing a cylinder of dielectric.

2175. WAVE GUIDES FOR ELECTRICAL TRANSMISSION.—G. C. Southworth. (*Elec. Engineering*, March 1938, Vol. 57, No. 3, pp. 91–95.)

2176. POLAR MOLECULES IN THE EARTH'S ELECTRIC FIELD AS ABSORBERS OF WIRELESS WAVES.—M. C. Holmes. (*Journ. Franklin Inst.*, March 1938, Vol. 225, No. 3, pp. 309–314.)

Water molecules oriented by the earth's electric field may be expected to resonate and cause absorption of energy at wavelengths of 0.3–2.3 m. A process analogous to anomalous dispersion might cause long-distance propagation along a layer, or reflection at vertical incidence.

2177. 5 M-WAVES, DELLINGER EFFECT, AND THE AURORAE [Long Distance Reception of 5 m Waves, and of 10 m Waves during Darkness, related to Dellinger Effect: Periodicity of 28 to 29 Days: Auroras frequently correspond also].—K. Stoye. (*E.N.T.*, Feb. 1938, Vol. 15, No. 2, pp. 35–36.)

2178. ON THE PROPAGATION OF HIGH-FREQUENCY RADIO WAVES OF ABOUT 30 Mc/s [Comparative Study of Reception from 75 and 3100 km: Two Modes of Propagation].—K. Maeda & T. Tukada. (*Rep. of Rad. Res. in Japan*, Oct. 1937, Vol. 7, No. 2, pp. 97–108.) *See* 1738 of May.

2179. THE ULTRA-HIGH FREQUENCIES: A REVIEW OF CONDITIONS IN 1937 [with Graphs of Daily Observations of Highest Receivable Frequency, for Distances more than 1200 Miles and for Distances up to 800 Miles].—D. W. Heightman. (*Wireless World*, 21st April 1938, Vol. 42, pp. 356–357.) Observations in 1938 (up to March) show a considerable drop in the upper frequency limit.

2180. STABILITY OF RECEPTION AT TWO METRES [Ultra-Short-Wave Fading Tests over 60 km Lawrenceville/Deal Path obstructed by Hill: with Charts].—A. Decino. (*Bell Lab. Record*, March 1938, Vol. 16, No. 7, pp. 244–247.)

2181. DEVIATION OF SHORT RADIO WAVES FROM LONDON/NEW YORK GREAT CIRCLE PATH [Observations using Steerable Receiving Aerial show Serious Deviations at Night: Large Deviations to the South are Common: Great Circle Path Normal in Daylight].—C. B. Feldman. (*Nature*, 19th March 1938, Vol. 141, pp. 510–511.)

2182. COMPARISON OF FIELD INTENSITIES OF SHORT WAVES RECEIVED SIMULTANEOUSLY FROM EUROPEAN STATIONS AT TWO DIFFERENT POINTS IN JAPAN [in 1935].—Amisima & others. (*Rep. of Rad. Res. in Japan*, Oct. 1937, Vol. 7, No. 2, pp. 75–89.)

2183. A NEW ATTACHMENT THEORY OF THE IONOSPHERE [Electrons disappear mainly by Attachment to Molecules or Neutral Atoms, not by Recombination: Negative Ions produced by Electron Attachment eject Electrons by Photoelectric Effect of Sunlight: Seasonal F_2 Variations explained without Assumption of Great Temperature Differences: etc.].—T. Tukada. (*Rep. of Rad. Res. in Japan*, Oct. 1937, Vol. 7, No. 2, pp. 121–144.)

2184. Ionisation, Negative-Ion Formation, and Recombination in the Ionosphere.—N. E. Bradbury. (*Terrestr. Magnetism*, March 1938, Vol. 43, No. 1, pp. 55–66.) The full paper, a summary of which was dealt with in 1757 of May.

2185. Constitution of the Ionosphere and the Lorentz Polarisation Correction, *and* A Fundamental Problem concerning the Lorentz Correction to the Theory of Refraction.—H. G. Booker & L. V. Berkner. (*Nature*, Vol. 141, 26th March 1938, Vol. 141, pp. 562–563 : *Science*, 18th March 1938, Vol. 87, pp. 257–258.)

(i) Observations, at the Department of Terrestrial Magnetism, on the reflection of waves of frequency less than the gyromagnetic frequency supports the Lorentz theory. Interpretation of observations by Martyn & Munro (1282 of April) is criticised. (ii) " Details of these observations will be published elsewhere. Comparison with Goubau's theoretical treatment leads us to believe that it is impossible to interpret these observations in terms of the Sellmeyer theory, but that no objection exists to their interpretation in terms of the Lorentz theory. It would appear therefore that it is the Lorentz theory which must be used in the ionosphere at oscillation frequencies employed in ordinary broadcasting. But since it is the Sellmeyer theory which must be used at sufficiently small oscillation frequencies we are faced with the following problem : At what frequency and in what manner does the transition from the Sellmeyer to the Lorentz theory take place ? "

2186. Effect of Longitudinal Magnetic Field on the Refractive Index and Conductivity of Ionised Air [Calculation by Method taking Collisional Frequency into Consideration : No Indication of Infinite Values : Agreement with Experiment].—S. S. Banerjee & B. N. Singh. (*Nature*, 19th March 1938, Vol. 141, pp. 511–512.)

2187. High-Frequency Characteristics of Ionised Gases [Experiments with Special Precautions to avoid Errors, showing Conductivity and Dielectric Constant to have Resonant Characteristics with respect to Wavelength, agreeing with Langmuir-Tonks " Plasma Resonance "].—Y. Asami & M. Saito. (*Nippon Elec. Comm. Eng.*, Feb. 1938, No. 9, pp. 16–23.)

2188. Accurate Measurements of the Luxemburg Effect.—G.W.O.H : Grosskopf. (*See* 2279.)

2189. The Heating of the Ionosphere by the Electric Currents associated with Geomagnetic Variations [Estimation of Magnitude — " Quite Insignificant " : Ionising Agent itself produces More Heating Effect], *and* The Heating of the Earth and Oceans by Induced Electric Currents.—S. Chapman. (*Terrestr. Magnetism*, Dec. 1937, Vol. 42, No. 4, pp. 355–358 : pp. 359–360.)

2190. Measurement of the True Height of the F Layer [at Calcutta, by Method of Murray & Hoag : True Height averages about 80 km less than Virtual Height, in Early Morning, Autumn 1937].—S. P. Ghosh. (*Science & Culture*, Calcutta, March 1938, Vol. 3, No. 9, p. 497.) For the method in question *see* 2454 of 1937 and back reference.

2191. Annual Variation of the Critical Frequencies of the Ionised Layers at Tromsö during 1937.—L. Harang. (*Terrestr. Magnetism*, March 1938, Vol. 43, No. 1, pp. 41–43.)

2192. Non-Seasonal Change of F_2-Region Ion Density [1935/1937 Results suggest that Cause is associated with the Earth or Its Motion].—L. V. Berkner & H. W. Wells. (*Terrestr. Magnetism*, March 1938, Vol. 43, No. 1, pp. 15–36.)

2193. On the Long-Period Variations in the F_2 Region of the Ionosphere [since May 1934 : Yearly Critical-Frequency Variations and Correlation with Sunspot Numbers : Both Seasonal and Annual Changes, acting Differentially in N. Hemisphere and Additively in S. Hemisphere : etc.].—K. Tani, Y. Ito, & H. Sinkawa. (*Rep. of Rad. Res. in Japan*, Oct. 1937, Vol. 7, No. 2, pp. 91–96.)

2194. Annual Variations in Upper-Atmospheric Ionisation [Measurements of E and F_2 Electron-Density Variations since 1934 : Equations for Critical Frequency, Number of Sunspots, and Zenith Angle of Sun].—K. Maeda, T. Tukada, & T. Kamoshida. (*Rep. of Rad. Res. in Japan*, Oct. 1937, Vol. 7, No. 2, pp. 109–119.)

2195. Radio Fade-Outs and the Associated Magnetic Variations [of Distinct Type, recognised by Birkeland in his " Norwegian Aurora Polaris Expedition 1902–1903 "].—S. Chapman. (*Terrestr. Magnetism*, Dec. 1937, Vol. 42, No. 4, pp. 417–419.) *See* pp. 419–420 for comments.

2196. On Theories of Magnetic Storms and Aurorae.—S. Chapman. (*Terrestr. Magnetism*, March 1938, Vol. 43, No. 1, pp. 77–79.)

2197. Heights of Electric Currents near the Auroral Zone.—A. G. McNish. (*Terrestr. Magnetism*, March 1938, Vol. 43, No. 1, pp. 67–75.)

2198. Aurora, Terrestrial Magnetism, and Wave Propagation [Survey, including Some Observations on 25th Jan. 1938].—O. Morgenroth. (*Funktech. Monatshefte*, March 1938, No. 3, pp. 65–70.)

2199. Solar Activity and Radio Reception in 1936.—J. H. C. Lisman. (*Tijdschr. Nederlandsch Radiogenoot.*, July 1937, Vol. 7, No. 5, pp. 141–148.)

2200. Final Relative Sunspot-Numbers for 1936 and Monthly Means of Prominence-Areas for 1909–1936.—W. Brunner. (*Terrestr. Magnetism*, Dec. 1937, Vol. 42, No. 4, pp. 391–394.)

2201. Ionospheric Observations: Eclipse of June 8, 1937 [at Huancayo & Watheroo: Data and Derived Conclusions].—Wells, Stanton, & Seaton. (*Terrestr. Magnetism*, March 1938, Vol. 43, No. 1, pp. 37–40.)

2202. Measurements of the Height of the Ionosphere at Heiho, Manchukuo, during the Solar Eclipse of June 19, 1936.—T. Nakamura. (*Nippon Elec. Comm. Eng.*, Feb. 1938, No. 9, pp. 28–31.) Already dealt with in 2456 of 1937.

2203. The Results of Measurements on Short-Wave Field Intensities during the Solar Eclipse of June 19th 1936.—K. Miya. (*Nippon Elec. Comm. Eng.*, Feb. 1938, No. 9, pp. 26–27.) A summary was dealt with in 21 of January.

2204. Characteristics of the Ionosphere at Washington, D.C., January 1938 [including Very Severe Ionosphere Storms and Prolonged Periods of Low-Layer Absorption: Causes of the 3 Distinct Types of Ionosphere Irregularities].—Gilliland & others. (*Proc. Inst. Rad. Eng.*, March 1938, Vol. 26, No. 3, pp. 379–382.)

2205. Effect of Catastrophic Ionospheric Disturbances on Low-Frequency Radio Waves.—Bureau. (*See* 2213.)

2206. The Ozonosphere and the Early-Morning Increase of the E-Layer Ionisation of the Ionosphere.—S. K. Mitra. (*Science & Culture*, Calcutta, March 1938, Vol. 3, No. 9, pp. 496–497.)

A preliminary report of Ghosh's recent observations. The time of increase of ionisation in the E layer is on the average 10 minutes after the sun's rays graze the surface of the earth; *i.e.* it agrees with the time when the rays pass over the top of the ozonosphere (at a height of about 35 km) and thus reach the E region without having their shorter wavelengths absorbed by the ozone. "In fact, the variation of the hour of the morning increase of the E-ionisation may be used as an index of the variation of the ozone in the upper atmosphere."

The writer continues: "There are, however, certain other points . . . the explanation of which is not quite so obvious as that given above for the increase occurring 10 minutes after sunrise." There is, in particular, the fact that the sun's rays, in order to reach the E-layer point under observation, had already to pass through the E layer at another point above the surface of the earth, separated by a distance of an arc of about 16½ degrees. "The fact that the solar rays when passing obliquely through the atmosphere are able to cause increase of ionisation only at a certain definite height of the atmosphere (the E-layer height) at two different places shows that the atmospheric constituents at such heights must possess certain characteristic properties which are not possessed by the constituents at the lower levels and which make them easily amenable to ionisation." Discussion of this point leads to the conclusion that the ionisation increase must be caused by the photo-ionisation of already excited molecules of N_2 and O_2 by wavelengths near 2000 A.U. (the only wavelengths longer than 1200 A.U. "which can survive absorption after passage through the length of the oblique path under consideration—0.52 km of O_2 and 1.95 km of N_2 at N.T.P."). The existence of excited N_2 molecules has already been established by observations on the light of the night sky.

2207. New Measurements on the Vertical Distribution of Ozone in the Atmosphere [by Sounding Balloon: Minimum Ozone Pressure at 5–12 km].—V. H. Regener. (*Naturwiss.*, 11th March 1938, Vol. 10, p. 155.)

2208. Measurements of Atmospheric Ozone at Heights of 13 and 14 Kilometres.—Konstantinova-Schlesinger. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, No. 6, Vol. 18, 1938, pp. 337–338: in French.) Further development of the work dealt with in 828 of March.

2209. Radiometric Measurements of Ultra-Violet Solar Intensities in the Stratosphere.—R. Stair & W. W. Coblentz. (*Journ. of Res. of Nat. Bur. of Stds.*, Feb. 1938, Vol. 20, No. 2, pp. 185–215.)

2210. Paper on the Absolute Measurement of Weak Field Strengths and the Calculation of the Austin-Cohen Coefficient in India.—Imam & others. (*See* 2486.)

2211. Discussion on "Propagation of Waves along Electric Lines: Graphical Method."—L. Bergeron. (*Bull. de la Soc. franç des Élec.*, Feb. 1938, Vol. 8, No. 86, pp. 120–131.) *See* 838 of March.

2212. Theory of the Propagation of Light in an Atomically Stratified Medium.—J. Weigle. (*Helvetica Phys. Acta*, Fasc. 2, Vol. 11, 1938, pp. 159–180: in French.)

"Up to now, this general theory has only been given for the cases where the length of the luminous wave was of the order of magnitude of the periodicity of the medium (X-ray or optical grating) or else much smaller than the latter, as with supersonic waves. It has seemed to us interesting to study the case where the wavelength of the light is much longer than the periodicities of the medium in which it is propagated. This problem is, in fact, that of the propagation of light in crystals: its solution will be found in the following pages."

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

2213. Effect of Catastrophic Ionospheric Disturbances on Low-Frequency Radio Waves [cause Increase in Atmospherics but Not on Frequencies below 17 kc/s].—R. Bureau. (*Nature*, 9th April 1938, Vol. 141 p. 646.)

2214. THE STRUCTURE OF THE MASSES OF AIR, AND RADIOELECTRIC PHENOMENA.—R. Bureau. (*Rev. Gén. de l'Élec.*, 2nd April 1938, Vol. 43, No. 14, p. 440 : summary only.)

2215. SOME NOTES ON SNOW STATIC.—V. J. Andrew. (*Communications*, March 1938, Vol. 18, No. 3, pp. 25 and 39, 40.)

2216. SOURCES OF ENERGY OF STORMS [Indian Science Congress Address].—C. W. B. Normand. (*Current Science*, Bangalore, Feb. 1938, Vol. 6, No. 8, p. 419 : summary only.)

2217. SOME RADIO-GEOLOGICAL VIEWPOINTS ON THE PLANNING OF LIGHTNING-PROTECTION ARRANGEMENTS.—V. Fritsch. (*Elektrot. u. Masch:bau*, No. 9, Vol. 56, 1938, pp. 105–112.)

2218. INTERNATIONAL HIGH-TENSION CONFERENCE, PARIS, 1937 : REPORT ON WORK ON LIGHTNING AND LIGHTNING PROTECTION.—(*Rev. Gén. de l'Élec.*, 5th Feb. 1938, Vol. 43, No. 6, pp.182–191.) *See* also 1783 of May.

2219. ON THE CURRENT-CONTROLLED DISCHARGE [Ionisation in Townsend or Glow Discharges proportional to Square of Current Density : Effect of Space Charge of Secondary Importance : Explanation by Collisions of Metastable Atoms].—R. Schade. (*Zeitschr. f. Physik*, Feb. 1938, Vol. 108, No. 5/6, pp. 353–375.)

2220. ON THE VARIATIONS OF COSMIC RADIATION DURING MAGNETIC STORMS, *and* RELATIONS BETWEEN TERRESTRIAL MAGNETISM AND COSMIC-RAY INTENSITY. — Johnson : Hess & others. (*Terrestr. Magnetism*, March 1938, Vol. 43, No. 1, pp. 1–6 : pp. 7–14.)

2221. VALUES OF THE MAGNETIC CONSTANTS AT THE OBSERVATORY OF CHAMBON-LA-FORÊT (LOIRET) ON 1ST JANUARY 1938 : MEAN VALUES FOR DECEMBER 1937–JANUARY 1938.—L. Éblé & J. Gibault. (*Comptes Rendus*, 14th March 1938, Vol. 206, No. 11, p. 851.)

2222. ATMOSPHERIC ELECTRICITY AT THE COLLEGE-FAIRBANKS POLAR-YEAR STATION.—K. L. Sherman. (*Terrestr. Magnetism*, Dec. 1937, Vol. 42, No. 4, pp. 371–390.)

PROPERTIES OF CIRCUITS

2223. THE MODULATION RESPONSE AND SELECTIVITY CURVES OF A RESONANT CIRCUIT LOADED BY A DIODE RECTIFIER [Treatment avoiding Assumption (made by Other Workers) of an "Effective Input Resistance" replacing the Diode].—F. C. Williams. (*Wireless Engineer*, April 1938, Vol. 15, No. 175, pp. 189–197.)

Further development of the work dealt with in 3618 of 1937. It is found that there is a marked difference between the "two signal" selectivity curve and the "one signal" tuning curve, and "one signal" selectivity tests can be very misleading. Further, "it appears that it may be possible to combine broad tuning with adequate selectivity by careful design of the rectifying stage."

2224. RELATIONS BETWEEN EXPONENTIAL VOLTAGE IMPULSES AND THE RESPONSE OF AN OSCILLATING CIRCUIT.—Lambert. (*See* 2308.)

2225. A BRIDGE BETWEEN THE THEORY OF THE BROADCAST-RECEIVER BAND FILTER [Coupled Circuits] AND THE THEORY OF THE FILTER NETWORK [and the Connections between the Terms Detuning, Coefficient of Coupling, Sharpness of Resonance, and Characteristic Impedance, Cut-Off Frequency, Transmission Range].—R. Feldtkeller. (*T.F.T.*, Feb. 1938, Vol. 27, No. 2, pp. 38–43.)

2226. CONTRIBUTION TO THE CALCULATION OF WAVE FILTERS [Very Full Account of Filters of Various Types, and Methods for designing High, Low, or Band Pass Filters to meet Given Requirements].—H. Piloty. (*E.N.T.*, Feb. 1938, Vol. 15, No. 2, pp. 37–64.)

2227. RESISTANCE BALANCING IN WAVE FILTERS. —G. Builder. (*AWA Tech. Review*, Jan. 1938, Vol. 3, No. 3, pp. 83–100.) Already dealt with in 1334 of April.

2228. BACK-COUPLED BAND FILTERS.—J. Steinmetz. (*Hochf:tech. u. Elek:akus.*, March 1938, Vol. 51, No. 3, pp. 112–115.)

The transmission characteristic of a variable band filter using valve retroaction is shown to be identical with that of a coupled filter, and to be symmetrical (except in two special cases) when resistive retroaction is used. Asymmetry due to self capacity of the coupling resistance or valve inter-electrode capacity cannot be neglected but may be removed by neutralisation. Filters using more than two oscillatory circuits may be operated with purely capacitive or inductive retroaction and consequently better symmetry.

2229. TRANSIENT PHENOMENA IN FILTERS.—P. Poincelot. (*Ann. des Postes, T. et T.*, March 1938, Vol. 27, No. 3, pp. 252–260.)

Generalisation of the results of the paper dealt with in 452 of February. Application of a sudden jump of voltage to the input of a low-pass filter : application of a sinusoidal voltage to the input of a band-pass filter : comparison of the action of a filter in the permanent régime and in the transient régime : conditions with which the transfer factor of a quadripole should conform.

2230. THE SMOOTHING OF THE IMPEDANCE CHARACTERISTIC OF A FILTER NETWORK [Zobel M-Type Filter] HAVING COIL LOSSES.—A. Gerrmann. (*T.F.T.*, Jan. 1938, Vol. 27, No. 1, pp. 13–17.) Extension of Zobel's work to include coil loss : condenser loss is neglected.

2231. PROPERTIES OF THE CONJUGATE ELEMENTS OF A QUADRIPOLE [with Application to Cauer (and Jaumann) Filters : Analysis and Geometrical Constructions].—R. Leroy. (*Ann. des Postes, T. et T.*, March 1938, Vol. 27, No. 3, pp. 195–209.)

2232. Operational and Matrix Methods in Linear Variable Networks [whose Parameters vary Continuously or Discontinuously with Time].—L. A. Pipes. (*Phil. Mag.*, April 1938, Vol. 25, No. 169, pp. 585–600.)

2233. Quadripoles with Continuously Variable Attenuation Characteristics.—K. H. Krambeer. (*T.F.T.*, Feb. 1938, Vol. 27, No. 2, pp. 43–47.)

2234. Variation of the Current entering a Quadripole when the Terminating Impedance is Short-Circuited.—M. Bayard. (*Ann. des Postes, T. et T.*, Feb. 1938, Vol. 27, No. 2, pp. 129–135.)

2235. Some Properties of Symmetrical-Resistance-Terminated Four-Terminal Symmetrical Networks.—R. Kamiya. (*Nippon Elec. Comm. Eng.*, Feb. 1938, No. 9, pp. 44-46.) Arising from the work of Kikuti & Hayasaka, 1805 of May.

2236. Representation of the Impedance of Lines by Passive Networks.—G. Chardon. (*Ann. des Postes, T. et T.*, March 1938, Vol. 27, No. 3, pp. 227–251.)

2237. On an Extension of Thévénin's Theorem.—H. Ataka. (*Phil. Mag.*, April 1938, Vol. 25, No. 169, pp. 663-666.)

2238. Ring-Type Wave Selector, *and* A New Type of Wave Separator.—M. Yoneyama : T. Nishizaki. (*Nippon Elec. Comm. Eng.*, Feb. 1938, No. 9, pp. 3–5 : pp. 6–9.)

2239. Duplex-Feedback Type of Amplifying Carrier Selector.—Watanabe, Kikuti, & Okamura. (*Nippon Elec. Comm. Eng.*, Feb. 1938, No. 9, pp. 10–15.)

2240. A New Circuit with a Space-Charge-Grid Tube [Increased Sensitivity, without Retroaction, by Added Resistance in Space-Charge-Grid Circuit : Theory and Experimental Confirmation].—H. Maeda. (*Electrot. Journ.*, Tokyo, April 1938, Vol. 2, No. 4, pp. 91–94.)

2241. Inductively Compensated Tetrode Amplifiers [Method of Analysis showing Limitations : Alternate Stage Compensation (to increase Stability) and Its Comparison with Individual Stage Compensation].—D. M. Johnstone. (*Wireless Engineer*, April 1938, Vol. 15, No. 175, pp. 208–211.)

2242. Experiments and Simple Calculations relating to High-Frequency Amplifiers functioning in Class C [Approximate Treatment based on Supposition that Anode Current flows only for Very Small Fraction of Period : Application of Laws of Direct Current : Particularly Useful for Ultra-High Frequencies, where D.C. Instruments are Preferable].—G. Lehmann. (*L'Onde Élec.*, March 1938, Vol. 17, No. 195, pp. 135–144.)

2243. Input and Output Impedances of [Negative-] Feedback Amplifier [Analysis and Experiment].—K. Kobayashi. (*Nippon Elec. Comm. Eng.*, Feb. 1938, No. 9, pp. 40–43.)

2244. A Study on [Gain, Phase, and Transient] Characteristics for the Fundamental Wave in a [Negative-] Feedback Amplifier.—K. Kobayashi & Y. Degawa. (*Nippon Elec. Comm. Eng.*, Feb. 1938, No. 9, pp. 79–82.)

2245. Negative-Feedback Amplifiers.—L. Chrétien. (*L'Onde Élec.*, Feb. 1938, Vol. 17, No. 194, pp. 81–99.) Conclusion of the survey referred to in 1342 of April.

2246. "Series" Inverse Feedback.—Amalgamated Wireless Valve Company. (*See* 2286.)

2247. Discussion on "Inverse-Feedback Amplifiers : Applications to Repeaters for H.F. Carrier Current Telephony."—J. Saphores. (*Bull. de la Soc. franç. des Élec.*, March 1938, Vol. 8, No. 87, pp. 227–233.) *See* 891 of March.

2248. Direct-Current Amplifiers : a Review [Discussion of Amplifiers for Measurement of Small D.C. Voltages or for Control of Relays, etc : the Bias Difficulty : Causes of Instability, including Photo-Sensitivity : Regeneration].—Aerovox Corporation. (*Electronics*, March 1938, Vol. 11, pp. 42 . . 50.)

2249. The Electron Tube in Schemes with Transmitters, Resistance, Inductance and Capacity [in Telemechanics : Variation of Mean Anode Current with Regulating Parameters *R, L, C* (forming Potentiometer or Phase Regulator) in Grid Circuit of Amplifier Valve].—V. E. Vartelsky. (*Automatics & Telemechanics* [in Russian], No. 4, 1937, pp. 7–28.)

2250. The Theory of Equivalent Transformation of Simple Partial Paths in the Relay Circuit.—A. Nakasima & M. Hanzawa. (*Nippon Elec. Comm. Eng.*, Feb. 1938, No. 9, pp. 32–39.)

2251. On the Design of an Over-Driven Frequency-Doubling Stage.—Evtyanov. (*See* 2276.)

2252. Discussion on "Relaxation, Synchronisation, and Demultiplication of Frequency."—Y. Rocard. (*Bull. de la Soc. franç. des Élec.*, March 1938, Vol. 8, No. 87, pp. 234–240.) *See* 3615 of 1937.

2253. Control of the Phase of Synchronised Relaxation Oscillations (Time Bases).—Hudec. (*See* 2450.)

2254. Interactions between Continuous-Current Closed Circuits.—M. Wolfke. (*Helvetica Phys. Acta*, Fasc. 2, Vol. 11, 1938, pp. 156–158 : in French.)

2255. The Magnetic Dispersion of Parallel Conductors placed between Screens of Infinite Permeability [at Any Angle : Treatment by Conformal Representation].—J. Kučera. (*Rev. Gén. de l'Élec.*, 19th March 1938, Vol. 43, No. 12, pp. 355–362.)

2256. Background Noise produced by Valves and Circuits.—Percival & Horwood. (*See* 2336.)

TRANSMISSION

2257. The Generation of [Ultra-Short-Wave] Oscillations by an Electron Ray in the Field of a Plate Condenser.—A. Recknagel. (*Zeitschr. f. tech. Phys.*, No. 3, Vol. 19, 1938, pp. 74–77.)

Following on the work of Hollmann & Thoma (2498 & 2914 of 1937: *see* also 4040 of 1937), of Gundlach and of Brüche & Recknagel (4039 of 1937 and 1353 of April 1938), the present paper gives a rather more complete and strict analysis of the problem. Author's summary:—"Into a plate condenser, to which a high-frequency deflecting voltage is applied, an electron beam is shot in a direction parallel to the plates. The influence current flowing between the plates is calculated. It is found that this current is displaced in phase with respect to the deflecting voltage, so that under certain conditions energy is given up to the condenser field and oscillations can be set up. The maximum mean energy delivery occurs when $p/2=\omega . l/2v=3.8$. Even when the electron ray enters the condenser field obliquely, or when a d.c. field is present in addition to the a.c. field, the induced current is given by the same formulae as for parallel entrance into the field."

2258. The Resotank, a New Generator for Micro-Waves [*e.g.* 14 cm].—A. Allerding, W. Dallenbach, & W. Kleinsteuber. (*Hochf: tech. u. Elek: akus.*, March 1938, Vol. 51, No. 3, pp. 96–99.)

A valve electrode system (for Barkhausen-Kurz or magnetron oscillations) is built within a high-Q tank in the form of a closed cylindrical resonator. Frequency is determined by the dimensions of the resonator, which may be fixed or variable (both types are seen in Fig. 7). The output is a pure wave, and not the mixture of frequencies often attributed to a retarding-field oscillator: the heterodyne note given by two Resotanks can be kept between 1000 and 2000 c/s for an hour at a time. As seen in Fig. 7, the d.c. voltage and heating current are supplied through a plug and socket at the bottom, a screened lead being used. The load circuit is coupled, preferably by way of a concentric feeder, with optimum coupling to the head of the Resotank cylinder, through a ceramic plate.

2259. [Ultra-] Short-Wave Transmitters with Spherical Circuits. — G.W.O.H: Hollmann. (*Wireless Engineer*, March 1938, Vol. 15, No. 174, pp. 126–127.)

Editorial on the paper by Hollmann (80 of January). An error in the treatment of the relation of wavelength to the linear dimensions is pointed out.

2260. Corrections to "On the Optimum Length for Transmission Lines used as Circuit Elements."—B. Salzberg. (*Proc. Inst. Rad. Eng.*, March 1938, Vol. 26, No. 3, p. 276.) *See* 907 of March. Four equations are corrected.

2261. Frequency Stabilisation of Ultra-Short Waves with the Help of Long Lines [Analysis].—J. L. W. C. von Weiler. (*Tijdschr. Nederlandsch Radiogenoot.*, July 1937, Vol. 7, No. 5, pp. 149–155.)

2262. "Sentron" Oscillators [for Ultra-Short and Micro-Waves] with Electron-Coupled Secondary Circuit.—S. Uda & M. Ishida. (*Electrot. Journ.*, Tokyo, April 1938, Vol. 2, No. 4, pp. 95–96.)

The oscillation circuit of the "Sentron" magnetron (520 of February) is ordinarily connected to the split anodes, and the output taken either directly from this circuit or from a secondary circuit coupled to it. In the new method the secondary circuit is connected to auxiliary electrodes inside the tube, giving electronic coupling between the two circuits. With proper connections, nearly equal outputs can be obtained from primary and secondary circuits. The method can be applied to other types of magnetron.

2263. Influence of the Orientation of the Filament, with respect to the Magnetic Field, on the Oscillations of a Magnetron [and Its Use for Varying the Wavelength (*e.g.*) from 23 cm–8 cm].—E. Pierret & J. Erard. (*Journ. de Phys. et le Radium*, March 1938, Vol. 9, No. 3, Supp. pp. 54–55 S.) Ordinarily, the same wavelength variation would have required an anode-voltage change from 540 to 4450 volts.

2264. Differentiation of the Various Types of Oscillation in a Habann Valve.—K. Lämmchen & A. Lerbs. (*Hochf:tech. u. Elek:akus.*, March 1938, Vol. 51, No. 3, pp. 87–95.)

It was found by experiment that all phenomena occurring in an oscillating split-anode magnetron could be deduced from the static characteristic. Experimental separation of Habann and transit-time oscillations showed that in the region in which both could occur, oscillation always began in the former mode and went over to the latter. It was found possible to suppress the Habann oscillation and to excite various transit-time waves; harmonics of the latter could be obtained without the fundamental appearing in the external circuit.

2265. Conductor-Core-Coil Oscillator of the So-Called B-Type Circuit [for Ultra-Short Waves: More Efficient than Ordinary (A-Type) and susceptible to nearly 100% Modulation: Other Advantages].—S. Ohtaka & K. Mano. (*Nippon Elec. Comm. Eng.*, Feb. 1938, No. 9, pp. 52–55.) For previous work on conductor-core-coil oscillators *see* 897 of March and 1824 of May.

2266. The Uniformly Controllable Gas-Filled Amplifier Valve and Its Application as High-Frequency Generator [including Ultra-High Frequencies].—Nienhold. (*See* 2326.)

2267. An Investigation of Ultra-Short-Wave Oscillators.—G. A. Zeitlenok. (*Izvestiya Elektroprom. Slab. Toka*, No. 1, 1938, pp. 4–17.)

Various factors peculiar to the operation of a triode on ultra-short waves are discussed, and equivalent circuits of a triode (Fig. 2) and, in a general form, of the oscillating circuit (Fig. 3) are shown. A mathematical analysis of the operation of different types of oscillating circuit is presented, and methods are derived for determining the frequency when the circuit constants are given, and *vice versa*. To illustrate the discussion, methods are also indicated for calculating the impedance of the anode circuit and the coefficient of back-coupling. It is suggested that the most suitable type of oscillating circuit is the one proposed by Esau (Fig. 7).

2268. Ultra-Short-Wave Quartz Oscillator [5.9 m with Fundamental Oscillation, 2.3 m with Third Harmonic: the Formation of "Sectional Oscillations" in Very Thin Quartz Plates].—Uda, Honda, & Watanabe. (*Electrot. Journ.*, Tokyo, April 1938, Vol. 2, No. 4, pp. 94–95.) Further development of the work dealt with in 1993 and 1994 of May. In "sectional oscillation" (which "has not yet been pointed out in the past") "the boundary of the vibrator is not air but is quartz itself."

2269. YT-Cut Quartz Plates for Short and Ultra-Short Waves.—Yoda. (*See* 2479.)

2270. A Crystal-Controlled 5- and 10-Metre Portable: Three-Tube Transmitter for Mobile Work [using "Bantam" Triode and Beam Tetrode for Oscillator].—F. F. Sylvester. (*QST*, April 1938, Vol. 22, pp. 46–47.) For "Bantam" valves *see* 2332, below.

2271. A Transmitter for Television Experiments.—Albricht. (*See* 2462.)

2272. Putting the Harmonic Generator to Work: Four-Band Transmitter with 814 [Beam Valve] Final.—J. L. Reinartz. (*QST*, April 1938, Vol. 22, pp. 15–17.) For previous work on the "fundamental-reinforced harmonic-generating circuit" *see* 3273 of 1937.

2273. Radio Progress during 1937: Part V—Report by the Technical Committee on Transmitters and Antennas.—(*Proc. Inst. Rad. Eng.*, March 1938, Vol. 26, No. 3, pp. 302–307.)

2274. Performance Characteristics of Multi-Electrode Vacuum Tubes as Modulator Amplifiers [for Narrow and Wide Working Ranges, and for Various Systems of Modulation].—S. Uda & K. Numazawa. (*Nippon Elec. Comm. Eng.*, Feb. 1938, No. 9, pp. 59–71.)

2275. The Use of Pentodes in Radio Transmitters [for Telegraphy and Telephony: Various Systems of Modulation: Measuring Equipment: etc.].—J. P. Heyboer. (*Philips Transmitting News*, Sept., Oct., & Nov. 1937, Vol. 4, Nos. 4, 5, & 6, pp. 1–10, 1–9, & 1–13: in German & English concurrently.)

2276. On the Design of an Over-Driven Frequency-Doubling Stage.—S. I. Evtyanov. (*Izvestiya Elektropròm. Slab. Toka*, No. 12, 1937, pp. 12–23.)

Continuing previous work (2594 & 3277 of 1937), the operation of a triode is examined for the cases when (a) $\xi \leq 1$ and (b) $\xi \geq 1$, where ξ is the ratio of the peak anode voltage swing to the steady anode voltage. It is assumed in each case that all voltages applied to the grid and anode circuits are known, and from this assumption analytical methods are derived for determining the shape of the grid and anode current impulses and the amplitudes of the first (fundamental) and second harmonics of these currents. A numerical example is added and the calculated results are plotted and compared with experimental curves.

2277. Comparison of Parallel and Series Coupling Circuits for Transmitters.—E. Green. (*Marconi Review*, April/June 1938, No. 69, pp. 22–36.) Concluded from 918 of March.

2278. Shock-Proofing the Transmitter: a Novel Tank-Circuit Arrangement ["Concentric Feed"] and Miscellaneous Suggestions for Reducing Danger of Injury from High Voltages.—L. C. Waller. (*QST*, April 1938, Vol. 22, pp. 31–33 and 72.)

RECEPTION

2279. Accurate Measurements of the Luxemburg Effect.—G.W.O.H: Grosskopf. (*Wireless Engineer*, April 1938, Vol. 15, No. 175, pp. 187–188.) Editorial on the paper dealt with in 1849 of May.

2280. Stability of Reception at Two Metres.—Decino. (*See* 2180.)

2281. A Single-Valve Portable Ultra-Short-Wave Receiver using a Triode-Pentode.—R. C. Frost. (*Television*, March 1938, Vol. 11, No. 121, p. 190.)

2282. Circuit Diagrams of German and Other Broadcast Receivers.—(*Rad., B., F. für Alle*, Oct. 1937, No. 188, Supp. pp. 161–189.)

2283. My "Home-and-Abroad" Receiver [for Mains Supply at Home and Battery Supply as Portable: Description and Two Full Size Working Drawings].—R. Oechslin. (*Rad., B., F. für Alle*, April 1938, No. 194, pp. 49–65 and inset Supplement.)

2284. Battery Portables of 1938.—(*Wireless World*, 31st March 1938, Vol. 42, pp. 289–292.)

2285. The Double Superheterodyne Receiver [Differing Objects in Use: Choice of First I.F: Whistles and Phantom Signals and Their Prevention: etc.].—E. G. Beard: Kinross. (*Wireless Engineer*, April 1938, Vol. 15, No. 175, pp. 211–212.) Reply to Kinross's letter (930 of March): *see* also 3295 of 1937.

2286. "Series" Inverse Feedback: Practical Application to Receiver Design [Simplicity and Low Cost: Good Characteristics: Good Transient Response].—Amalgamated Wireless Valve Company. (*Rad. Review of Australia*, Aug. 1937, Vol. 5, No. 8, pp. 201 and 228.) For use with resistance-coupled amplifiers. For a previous paper *see* 3263 of 1937.

2287. The Linear Reflex Detector [" of Undoubted Interest and appears to possess Distinct Possibilities "].—C. P. Healy & H. A. Ross. (*Rad. Review of Australia*, Oct. 1937, Vol. 5, No. 10, pp. 282–284.) Reprint of the paper dealt with in 4062 of 1937.

2288. A Useful Heating Circuit for Universal Receivers [the Körting " Economy " Circuit, with Transformer and Resistance].—H. Richter. (*Rad., B., F. für Alle*, April 1938, No. 194, pp. 68–70.) On d.c. mains the transformer combines with a condenser to form a smoothing filter, particularly welcome on mercury-vapour-rectifier mains systems.

2289. The Mixing-Hexode as a Phase-Reversal Valve.—Schäfer. (*See* 2352.)

2290. Voltage Stabiliser: Preventing Fluctuations in HT Supply [for Measuring and Testing Instruments: Applicable also for Minimising Drift in Short-Wave Receivers: American Circuits on AVC Principle].—Taylor. (*Wireless World*, 14th April 1938, Vol. 42, pp. 341–342.) An article based on the work dealt with in 3654 of 1937 and 943 of March.

2291. Radio Progress during 1937: Part III—Report by the Technical Committee on Radio Receivers.—(*Proc. Inst. Rad. Eng.*, March 1938, Vol. 26, No. 3, pp. 291–297.)

2292. Recent Developments in Push-Button Tuning.—(*Communications*, March 1938, Vol. 18, No. 3, pp. 18–19.)

2293. A New System of Inductive Tuning [Rigid Coil on Spirally Grooved Rotating Former: Carriage, sliding on Bar parallel to Axis, is driven by Insulated Grooved Wheels riding on Wire and carries Bifurcated Contact Spring: Suitable for Wavelengths down to Ultra-Short: Possibility of Automatic Band-Switching: etc.].—P. Ware. (*Proc. Inst. Rad. Eng.*, March 1938, Vol. 26, No. 3, pp. 308–320.)

2294. Dynamic [Contrast] Regulation at the Receiver [General Considerations, with List of Faults and Their Causes].—H. Boucke. (*Funktech. Monatshefte*, March 1938, No. 3, pp. 83–88.) To be completed by a second part dealing with practical development.

2295. Low-Distortion Volume Expansion using Negative Feedback [applicable also to Distortionless Compression: Defects of Variable-Mu and Bridge-Type Systems avoided].—B. J. Stevens. (*Wireless Engineer*, March 1938, Vol. 15, No. 174, pp. 143–149.)

2296. Automatic Frequency Correction [with Graphical Methods of estimating Performance of Any Given Circuit or determining Circuit Characteristics for Any Required Performance: confirmed by Rigorous Analytical Investigation].—O. E. Keall & G. Millington. (*Marconi Review*, April/June 1938, No. 69, pp. 1–21.)

2297. " Electron Star " Application [Fitting the Philips Type EM 1 " Clover Leaf " Tuning Indicator].—(*Rad. Review of Australia*, Oct. 1937, Vol. 5, No. 10, pp. 288 and 290.)

2298. The Marked Difference between " Two Signal " Selectivity Curve and " One Signal " Tuning Curve in a Diode Circuit: the Possibility of Broad Tuning combined with Adequate Selectivity.—Williams. (*See* 2223.)

2299. Selectivity Measurements on Broadcast Receiving Apparatus.—Th. J. Weijers. (*Tijdschr. Nederlandsch Radiogenoot.*, July 1937, Vol. 7, No. 5, pp. 156–172.)

2300. Standardisation of Tests on Receivers: Definition of Terms, etc: Tests on Sensitivity [Suggestions of Société des Radioélectriciens Committee]. — (*L'Onde Élec.*, March 1938, Vol. 17, No. 195, pp. 145–150.) Selectivity tests will be dealt with later.

2301. Criticism of " A Review of Radio Interference Investigation " [Most Broadcast Receivers " play Any Number of Stations as well as All the Noise in the Vicinity " without Any Aerial: Serious Need for Better Screening].—H. N. Kalb: Sanford & Weise. (*Elec. Engineering*, March 1938, Vol. 37, No. 3, pp. 137–138.) *See* 482 of February.

2302. The Application of Symmetrical Band-Rejector Filters to the Broadcast Wave-Range [as Wave Traps for Local-Station Interference]. — K. Steffenhagen. (*Funktech. Monatshefte*, March 1938, No. 3, pp. 73–74.)

2303. Car Radio Installation [and the Problems of Signal Pick-Up and Interference Suppression].—S. Daniel & J. B. Kaye. (*Wireless World*, 31st March 1938, Vol. 42, pp. 274–276.)

2304. Yet Another Possible Source of Interference: the Scale Illumination [Periodically Varying Contact between End of Lamp Filament and Its Support].—K. Nentwig. (*Rad., B., F. für Alle*, April 1938, No. 194, pp. 70–72.)

2305. Electrical Interference with Radio Reception.—A. J. Gill & S. Whitehead. (*Electrician*, 8th April 1938, Vol. 120, p. 455: summary of I.E.E. paper.)

2306. Comprehensive Investigation of Low-Frequency Broadcast Interference due to Mains Supply by Six-Phase Mercury-Vapour Rectifiers without Control Grids, *and* On the Problem of Low-Frequency Broadcast Interference from Rectifier Mains Supply.—Moebes & Scheel: Moebes. (*T.F.T.*, Feb. 1938, Vol. 27, No. 2, pp. 47–52: *E.T.Z.*, 24th March 1938, Vol. 59, No. 12, pp. 311–315.)

2307. An Interference-Free Electrically-Heated Cushion [with Specially Designed Bimetallic-Strip Thermostat giving Quick, almost Arc-less Break].—H. Krammer: Siemens-Schuckert. (*Elektrot. u. Masch: bau*, No. 11, Vol. 56, 1938, p. 145.)

2308. Relations existing between Voltage Impulses of Exponential Form and the Response of an Oscillating Circuit [Analysis using Duhamel's Superposition Integral: Oscillographic Confirmation: Graphical Determination of Constants of Impulse: Conclusions of Interest in connection with Radio Interference].—R. Lambert. (*Proc. Inst. Rad. Eng.*, March 1938, Vol. 26, No. 3, pp. 372–378.)

AERIALS AND AERIAL SYSTEMS

2309. A New Principle in Directional Antenna Design.—W. W. Hansen & J. R. Woodyard. (*Proc. Inst. Rad. Eng.*, March 1938, Vol. 26, No. 3, pp. 333–345.)

Considerable improvement of present designs (*e.g.* of end-fire arrays, and ring arrays for strong vertical and no horizontal directivity) if strict phase agreement at large distances in max. direction is abandoned; possibilities of a two-group system, one (for ground wave only) for daytime, both together (giving ground and sky waves *with space between*) for increased service area at night; etc.

2310. Transmitting Aerials excited at Any Point.—E. Siegel. (*Hochf:tech. u. Elek:akus.*, March 1938, Vol. 51, No. 3, pp. 101–109.)

It is shown that the feeding of an antenna at any point becomes a simple transformer problem when the effective resistance and reactance of the aerial are known: methods of calculating these are given. The distribution of voltage and current along the aerial are studied, and also the application of a knowledge of the current distribution to the calculation of the radiated energy.

2311. On the Field of a Vertical Half-Wave Aerial at Any Height above a Plane Earth of Any Dielectric Constant and Conductivity.—K. F. Niessen. (*Ann. der Physik*, March 1938, Vol. 31, No. 6, pp. 522–530.)

Weyl's expression for the Π function of an aerial at a distant point (eqn. 1) is discussed. The correction term $K(\phi)$ has been evaluated independently by Weyl and by Niessen, and similar reasoning is now applied to obtain a more complete expression (eqn. 7) which holds at a point close to the aerial.

2312. A Rotatable Directional Aerial for Short-Wave World Broadcasting.—Philips Company. (*Philips Transmitting News*, Dec. 1937, Vol. 4, No. 6, pp. 14–20: in German & English concurrently.) *See* also 1415 of April.

2313. The Design of a Transmitting Rhombic Aerial.—V. D. Kryzhanovski. (*Izvestiya Elektroprom. Slab. Toka*, No. 12, 1937, pp. 24–29.)

Formulae are quoted for determining the efficiency (4 and 4′) and radiation resistance (5 and 5′) of the aerial, and for calculating the vertical (8) and horizontal (9) polar diagrams. Formulae are also derived for determining the coefficient of directivity in the horizontal plane (12) and the optimum wavelength. The choice of the main physical parameters of the aerial is discussed (the length of the side, the angle facing the axis, and the height above the ground) and methods are indicated for designing the terminating iron-wire line.

2314. The Radiation Characteristics of a Vertical Broadcasting Antenna [and the Influence of the Horizontal Section and of "Folding Back," etc.]—Kayano, Nakamura, & Sonobe. (*Nippon Elec. Comm. Eng.*, Feb. 1938, No. 9, pp. 94–95.) A summary was dealt with in 117 of January.

2315. New Vertical Broadcasting Antenna [625 ft Tower] for Station WGY at Schenectady.—E. G. Semon & others. (*Gen. Elec. Review*, March 1938, Vol. **41**, No. 3, pp. 134–137.)

2316. Flat-Top Beam Antennas [with High Gain but Small Area], *and* Results with the W8JK [Flat-Top] Beam Antenna.—J. D. Kraus: R. T. Dealey. (*Television*, Feb. 1938, Vol. 11, No. 120, pp. 101–102: March 1938, No. 121, p. 178 and 180.)

2317. The Johnson "Q" Antenna System [with Aluminium-Tubing $\lambda/4$ Matching Section: for Short-Wave Transmission or Reception].—H. W. Stewart & E. W. Pickard. (*Television*, April 1938, Vol. 11, No. 122, pp. 231–232.)

2318. Experimental Results from the Musa [Multiple-Unit Steerable Antenna: Tests on a Six-Unit Model on Signals from England & Nova Scotia].—C. F. Edwards. (*Bell Lab. Record*, March 1938, Vol. 16, No. 7, pp. 232–235.) For previous papers *see* 1414 of April.

2319. A Tuned Loop for 80- and 160-Metre Reception: Compact Directivity for improving Portable and Emergency Operation [4 Turns in 20″ Diam. Copper Tube Ring, with 5th Turn as Link Coupling: Rotatable in Both Planes].—J. P. Tynes. (*QST*, April 1938, Vol. 22, pp. 10–11.)

2320. Radio Progress during 1937: Part V—Report by the Technical Committee on Transmitters and Antennas.—(*Proc. Inst. Rad. Eng.*, March 1938, Vol. 26, No. 3, pp. 302–307.)

2321. ON THE THEORY OF THE EARTH LOSSES OF AERIALS [with Some German P.O. Measurements on Radial-Wire Earths, etc.].—H. Brückmann. (*T.F.T.*, Feb. 1938, Vol. 27, No. 2, pp. 29–38.)

2322. PROTECTIVE CIRCUITS [against Lighting] FOR ANTENNA-COUPLING NETWORKS.—F. C. Ong. (*Bell Lab. Record*, March 1938, Vol. 16, No. 7, pp. 254–256.)

2323. CONTRIBUTION TO THE STUDY OF ELECTRIC LINES ENCRUSTED WITH FROZEN MATERIAL [Practical Calculations by a New Method]. —L. Labaume. (*Rev. Gén. de l'Élec.*, 19th Feb. 1938, Vol. 43, No. 8, pp. 227–240.)

VALVES AND THERMIONICS

2324. ULTRA-SHORT AND DECIMETRE-WAVE VALVES: DEFLECTION OF A FOCUSED BEAM OF ELECTRONS AS A POSSIBLE BASIS FOR CONSTRUCTION [Preliminary Experimental Work and Approximate Analysis: Suggested Combination of Deflectional Control with Cumulative Secondary-Emission Amplification, to give Very High Effective Mutual Conductance].—F. M. Colebrook. (*Wireless Engineer*, April 1938, Vol. 15, No. 175, pp. 198–201.)

2325. ON "PHASE FOCUSING" OF ELECTRONS IN MOTION IN [Ultra-] HIGH-FREQUENCY ELECTRIC FIELDS.—E. Brüche & A. Recknagel. (*Zeitschr. f. Physik*, March 1938, Vol. 108, No. 7/8, pp. 459–482.)

Phenomena at high frequencies involving electron transit time need for their full development a co-phasal motion of electrons forming a space charge. Methods of securing this by "phase focusing" are described, and the analogy with geometrical optics developed.

2326. THE UNIFORMLY CONTROLLABLE GAS-FILLED AMPLIFIER VALVE AND ITS APPLICATION AS HIGH-FREQUENCY GENERATOR [including Ultra-High Frequencies].—J. Nienhold. (*E.T.Z.*, 31st March 1938, Vol. 59, No. 13, pp. 329–333.)

High-frequency generators are becoming more and more wide in application—they are needed for wireless telegraphy and telephony, for diathermy, for electro-metallurgy, for drying out of materials, for refining chemicals, for destroying pests, etc. Of the numerous types of generator—alternators, quenched sparks, high-vacuum valves and gas-filled valves—a special type developed by the writer (his patents range from 1916 to 1928) is at present little known in electrotechnical practice. In this form of gas-filled valve (Fig. 1) the usual electron-emitting filament is replaced by a plasma produced by a discharge between a cathode *K* (which may be a mercury cathode, or a hot filament, or an indirectly heated cathode, according to the use to which the valve is to be put) and an "exciter anode" *EA*. From this plasma in the "exciting space" the electrons pass through *EA* to the "control space" between *EA* and the main anode *A*. This space contains the control grid *G*. Since the exciting space has to contain an inert gas or metal vapour, the control space must also contain this, and in the ordinary way the electrons entering this space would ionise the gas atoms, with the result that the negative control grid *G* would become coated with a cloud of positive ions which would spoil its control action. In the writer's valve, however, the distance between the boundaries of the control space (the electrodes *EA* and *A*) is made very small, smaller than the mean free path of the electrons, so that the electrons reach the anode without colliding with the gas atoms and there is no ionisation around the control grid. Such precision in the spacing of the electrodes is made possible by the use of modern ceramic insulating materials. It is this special point of non-ionisation in the control space which distinguishes the writer's design from other gas-filled valves recently developed, in which there is ionisation in the neighbourhood of the anode. The writer's valves have so far been made for outputs of about 100 w and anode voltages up to 1000 v, and in the Hartley connection have given wavelengths as short as 10–20 m. Suitable design should enable still shorter wavelengths to be attained. Telephony modulation is easy, by acting on the exciter circuit, not on the control grid.

2327. "SENTRON" OSCILLATORS WITH ELECTRON-COUPLED SECONDARY CIRCUIT.—Uda & Ishida. (*See* 2262.)

2328. THE RESOTANK, A NEW GENERATOR FOR MICRO-WAVES.—Allerding & others. (*See* 2258.)

2329. EXCESS-ENERGY ELECTRONS AND ELECTRON MOTION IN HIGH-VACUUM TUBES [causing Overheating, by Bombardment, of Cathode in Magnetrons: Important also for Bearing on Transit Time, Orbit Shape, Tube Noise, Shape of Cut-Off Curve, etc: Current and Space-Charge Phenomena for Electrons executing Cyclic Orbits (Magnetrons and Positive-Grid Valves): etc.].—E. G. Linder. (*Proc. Inst. Rad. Eng.*, March 1938, Vol. 26, No. 3, pp. 346–371.)

2330. NEW MAGNETIC-FIELD VALVES [Survey].—H. E. Hollmann. (*Funktech. Monatshefte*, March 1938, No. 3, pp. 75–79.)

The "Sentron" and "Double-Sentron" (Uda & others, 2262, above) and the similar valve developed by Helbig [Haelbig]—131 of January; the Okabe electron-beam magnetron (132 of January); the "Osaka" valve (half-way between a retarding-field valve and a magnetron: Okabe, 925 of 1937); and secondary-emission electron-multiplier magnetrons (Okabe, 4123 of 1936 and 1049 of 1937).

2331. [Ultra-] HIGH-FREQUENCY TRIODE OSCILLATORS [Transit-Time Effects: Principle of Similitude: Power Output: Grid Temperature: Efficiency: with Curves].—G. Reber. (*Communications*, March 1938, Vol. 18, No. 3, pp. 13–15.)

2332. NEW TUBES [including Gammatron 54 for Ultra-High Frequencies: Hytron "Bantams" for Space Economy: etc.].—(*Communications*, March 1938, Vol. 18, No. 3, pp. 21–22 and 26.)

2333 NEW RECEIVING TUBES: TYPE 1851 TELEVISION TUBE [Amplifier Pentode with Very High Grid/Plate Transconductance].—RCA. (*QST*, April 1938, Vol. 22, p. 98.)

2334. THE APPLICATION OF SECONDARY EMISSION IN AMPLIFYING VALVES [Limitations and Possibilities: Construction of Valve with Indirectly Heated Cathode, giving Amplification by Secondary Emission: Electrons deflected to reach Secondary Cathode, so that Latter can be Screened from Volatilised Materials which would vary Coefficient of Secondary Emission].—J. L. H. Jonker & A. J. W. M. van Overbeek. (*Wireless Engineer*, March 1938, Vol. 15, No. 174, pp. 150–156.)

2335. A THEORY OF NOISE FOR ELECTRON MULTIPLIERS.—Shockley & Pierce. (*See* 2438.)

2336. BACKGROUND NOISE PRODUCED BY VALVES AND CIRCUITS [Short Review, followed by Treatment of Triode by Analogy with Diode: Formula for Equivalent Temperature: Valve-Noise Measurement by Method with Anode joined Capacitively to Grid: Description of Apparatus: Comparison between Theory and Measured Results on Commercial Triodes, Beam Valves, Pentodes, etc.].—W. S. Percival & W. L. Horwood. (*Wireless Engineer*, March & April 1938, Vol. 15, Nos. 174 & 175, pp. 128–137 & 202–207.) For Bell's criticism of the first part *see* April issue, p. 213.

2337. EXPERIMENTS AND SIMPLE CALCULATIONS RELATING TO CLASS C H.F. AMPLIFIERS.—Lehmann. (*See* 2242.)

2338. THE OPERATION OF A TRIODE WHEN GRID CURRENT FLOWS.—A. I. Berg. (*Izvestiya Elektroprom. Slab. Toka*, No. 12, 1937, pp. 6–11.)

In previous papers (3333 of 1937 and 1431 of April) the effect of grid current on the static characteristics of the anode current was examined. In this paper a further analysis of the operation of a triode is presented. Equations (15 & 23) are derived determining the dynamic characteristics of the grid and anode currents respectively, and the shape of the current impulses is discussed for the cases when the grid current (a) flows and (b) does not flow. All possible operating conditions of a triode are shown in tabular form (Fig. 11), and methods are indicated for determining various operating constants. A numerical example added indicates that the accuracy of the theoretical results so obtained is of the order 5% to 10%.

2339. RELATION BETWEEN GRID EXCITATION AND AMPLIFICATION CONSTANT OF TRANSMITTING TUBES [and Its Connection with Secondary Emission at Grid].—M. Simbori. (*Nippon Elec. Comm. Eng.*, Feb. 1938, No. 9, pp. 56–58.)

2340. MEASUREMENT OF GRID CURRENTS IN THERMIONIC VALVES [Simple Method for Currents of Order of 10^{-9} Ampere].—E. W. Wilcox. (*Journ. Scient. Instr.*, April 1938, Vol. 15, No. 4, pp. 137–138.)

2341. A NEW METHOD FOR PLOTTING THE CHARACTERISTICS OF TRANSMITTING VALVES [Objections to Usual Short-Time Method of avoiding Deterioration during Test: Oscillographic Image, Stable enough for Tracing on Transparent Paper, by utilising One Cycle out of 10 or 20 of 50 c/s Mains].—R. Stuart. (*Bull. de la S.F.R.*, 4th Quarter 1937, Vol. 11, No. 5, pp. 151–168.)

2342. REBUILDING TRANSMITTER TUBES.—J. W. Jaffray. (*Communications*, March 1938, Vol. 18, No. 3, pp. 17 and 26, 30.)

2343. THE USE OF PENTODES IN RADIO TRANSMITTERS.—Heyboer. (*See* 2275.)

2344. PERFORMANCE CHARACTERISTICS OF MULTI-ELECTRODE VALVES AS MODULATOR AMPLIFIERS.—Uda & Numazawa. (*See* 2274.)

2345. THE STUDY AND REALISATION OF A SEALED TRANSMITTING VALVE OF 350 KILOWATTS EFFECTIVE POWER [Type E.3051]. — R. Warnecke. (*Bull. de la S.F.R.*, 1st Quarter 1938, Vol. 12, No. 1, pp. 1–29: *L'Onde Élec.*, Feb. 1938, Vol. 17, No. 194, pp. 49–80.) The latter version includes three appendices which are not in the former, but lacks a footnote which the former version contains.

2346. HIGH-POWER VALVES: CONSTRUCTION, TESTING, AND OPERATION.—J. Bell, J. W. Davies, & B. S. Gosling. (*Electrician*, 1st April 1938, Vol. 120, p. 414: summary of I.E.E. paper.)

2347. "ELECTRONENRÖHREN" [Vol. 4—Rectifiers and Receiving Valves: Book Review].—H. Barkhausen. (*Zeitschr. f. tech. Phys.*, No. 4, Vol. 19, 1938, pp. 118–119.)

2348. CRITICAL DISTANCE VALVES AND BEAM TETRODES [are One and Same Type of Valve: Many Years' Precedence for British Invention].—J. H. O. Harries. (*Wireless Engineer*, April 1938, Vol. 15, No. 175, pp. 212–213.)

2349. A NEW CIRCUIT WITH A SPACE-CHARGE-GRID TUBE [Increased Sensitivity, without Retroaction, by Added Resistance in Space-Charge-Grid Circuit: Theory and Experimental Confirmation].—H. Maeda. (*Electrot. Journ.*, Tokyo, April 1938, Vol. 2, No. 4, pp. 91–94.)

2350. INVESTIGATIONS ON "PLATION" VALVES [deriving from the de Forest Valve with Filament between Anode and Control Electrode: Determination of Current Distributions for Various Forms of Electrode: Advantages of Various Types].—O. N. Inceler. (At Patent Office Library, London: Cat. No. 78 364: 82 pp.)

2351. RADIO PROGRESS DURING 1937: PART II—REPORT BY THE TECHNICAL COMMITTEE ON ELECTRONICS. — (*Proc. Inst. Rad. Eng.*, March 1938, Vol. 26, No. 3, pp. 285–290.)

2352. THE MIXING-HEXODE AS A PHASE-REVERSAL VALVE.—O. Schäfer. (*Hochf:tech. u. Elek:akus.*, March 1938, Vol. 51, No. 3, pp. 109–112.)

A circuit is given using the hexode as a phasereversing valve for uniform amplification of frequencies from 0 to 10^5 c/s. All commercial types are not equally satisfactory, and their behaviour cannot be predicted from the usual characteristics. The choice of suitable valves is discussed and the Telefunken RENS 1224 recommended.

2353. Sharp Cut-Off in Vacuum Tubes, with Applications to the Slide-Back Voltmeter.—Aiken & Birdsall. (*See* 2491.)

2354. Are High-Slope Valves Wanted? [Early Misconceptions of Valve Action not yet entirely Dispelled: Dependence of Optimum Slope on Circuit Constants].—W. E. Benham. (*Wireless World*, 21st April 1938, Vol. 42, pp. 352–353.)

2355. Some 1938–1939 Philips Valves [including Electron-Beam Pentodes and Octodes].—Philips Company. (*L'Onde Élec.*, Feb. 1938, Vol. 17, No. 194, p. 104.)

2356. The New Receiving Valves at the Exhibition - Demonstration of Components, Accessories, and Valves (Paris, Feb. 1938).—M. Adam. (*Rev. Gén. de l'Élec.*, 26th March 1938, Vol. 43, No. 13, pp. 405–413.)

2357. Recent Developments in Tantalum and Columbium [and the Use of the Former for Valves and Electrolytic Condensers].—C. W. Balke. (*Indust. & Eng. Chemistry*, March 1938, Vol. 30, No. 3, pp. 251–254.)

2358. Stationary and Variable Temperature Distributions along Wires and Bars heated by Conduction Currents or by Radiation.—J. Fischer. (*Zeitschr. f. tech. Phys.*, No. 4, Vol. 19, 1938, pp. 105–113.) Conclusion of the paper referred to in 1896 of May.

DIRECTIONAL WIRELESS

2359. Marker Beacons for Symmetrical Radiation [Beacons for indicating Flying Hazards or for assisting Navigation have Requirements quite Different from Those of Blind-Landing Marker Beacon: Analysis leading to a "Stacked Radiator" Array giving Blunt-Nosed Circularly Polarised Ultra-Short-Wave Vertical Beam reaching to at least 10 000 Feet].—A. L. Green. (*AWA Tech. Review*, Jan. 1938, Vol. 3, No. 3, pp. 113–142.)

2360. The Advantages of Ultra-Short Waves for Aircraft Radio-Beacons [including the Absence of "Multiple Courses"].—(*Sci. News Letter*, 12th March 1938, Vol. 33, p. 165.) Based on U.S.A. Bureau of Air Commerce experiments.

2361. Corrections to "The Ultra-Short-Wave Guide-Ray Beacon and Its Applications."—Kramar & Hahnemann. (*Proc. Inst. Rad. Eng.*, March 1938, Vol. 26, No. 3, p. 276.) *See* 1900 of May.

2362. A New Blind Landing System [giving Straight Glide Approach (with Advantages of Slower Approach Speed, etc.): Triple Cathode-Ray Tube, giving Three Spots reproducing (in conjunction with Artificial Horizon) the Metcalf "Three Reference Landing Lights" System].—I. R. Metcalf. (*Science*, 18th March 1938, Vol. 87, Supp. p. 9.)

2363. The Philips Ultra-Short-Wave Radio Beacon Type B.R.A.075/4.—P. Zijlstra. (*Philips Transmitting News*, Dec. 1937, Vol. 4, No. 6, pp. 21–33: in German & English concurrently.)

2364. The Reduction of Night Error by the Adcock Aerial System [Advantages of Author's Modification with H.F. Transformer (Electrostatic Screen between Primary & Secondary) at Base of Each Aerial, and Lead-Covered Transmission Lines: Radiogoniometers RC6A].—H. Busignies. (*L'Onde Élec.*, March & April 1938, Vol. 17, Nos. 195 & 196, pp. 105–127 & 195–210.)

2365. Explanation of the Principle of an Automatic Radiogoniometer.—G. Lehmann. (*L'Onde Élec.*, Feb. 1938, Vol. 17, No. 194, pp. 102–103.) Report of a paper read before the Société des Radioélectriciens on 19th Jan. 1938. *See* also 1446 of April.

2366. New Aircraft Equipment for the Royal Dutch Air Lines (K.L.M.).—(*Philips Transmitting News*, Sept. 1937, Vol. 4, No. 4, pp. 10–12: in German & English concurrently.)

2367. "Aircraft Radio" [Book Review].—D. H. Surgeoner. (*Wireless Engineer*, April 1938, Vol. 15, No. 175, p. 197.)

ACOUSTICS AND AUDIO-FREQUENCIES

2368. On the Effect of the Ohmic Resistance of the Moving Coil on the Frequency Characteristic of a Dynamic Loudspeaker.—L. D. Rosenberg. (*Izvestiya Elektroprom. Slab. Toka*, No. 12, 1937, pp. 37–38.)

It is generally believed that the use of a high-resistance moving coil affects adversely the performance of the loudspeaker at higher frequencies, since such a coil has a larger number of turns and therefore a higher inductance. It is shown in the present paper that the adverse effect, if any, is not caused by the increased inductance of the coil.

The operation of the final stage of amplification at the higher frequencies is discussed, and it is shown that when $Z/R_i > 1$ (where Z is the impedance of the coil and R_i the internal resistance of the valve) the current through the coil is determined by R_i and is independent of Z, while when $Z/R_i < 1$ a certain diminution of the current through the coil takes place but this is determined solely by the volume of copper used for the coil and is independent of the number of turns or resistance of the coil.

The case when $Z/R_i = 1$ is seldom met in practice and therefore is not considered.

2369. The Impedance of the Voice Coil of a Loudspeaker [Theoretical and Experimental Investigation of Behaviour near Resonant Frequency: leading to a Discussion of Effects with Triodes and Pentodes, and Some Notes on Power Amplifiers].—J. B. Rudd. (*AWA Tech. Review*, Jan. 1938, Vol. 3, No. 3, pp. 100–112.)

"It would appear that a performance [with a pentode] comparable with that which can be obtained with a triode is only possible by using some system of inverse feedback which will be effective in reducing the anode a.c. resistance of the pentode to a value similar to that of a triode."

2370. Measurement of the Vector Diagram of a Dynamic Loudspeaker.—M. Gordon & A. Türkel. (*Hochf:tech. u. Elek:akus.*, March 1938, Vol. 51, No. 3, pp. 99–100.)

Study of the impedance of a loudspeaker as a function of frequency, by measurement of the total and individual voltages developed across the loudspeaker and a pure resistance in series.

2371. The Rôle of the Speaker Impedance in Resonance in a Closed Pipe [Analysis of a Standing-Wave Resonance System used for Microphone Investigations: leading to a Method of measuring Loudspeaker and Microphone Impedance].—W. D. Phelps. (*Journ. Acoust. Soc. Am.*, April 1938, Vol. 9, No. 4, pp. 308–311.)

2372. On Improving the Articulation of Loudspeakers in an Auditorium with a Noisy Background.—B. F. Vysotski & S. I. Tetelbaum. (*Izvestiya Elektroprom. Slab. Toka*, No. 1, 1938, pp. 17–21.)

It is pointed out that "compression" of speech in transmission, without subsequent "expansion," considerably affects the quality but not the intelligibility of reception. Accordingly an experimental investigation was carried out to determine whether this method could be used for raising the efficiency of public-address systems installed in places with a noisy background, such as a sports stadium or railway station. In the circuit used for these experiments (Fig. 1) facilities were provided for a maximum compression of speech, *i.e.* for transmission of sounds of various intensities at the same (maximum) level, while the interfering noise was artificially produced by a gramophone. Observations were then made of the intelligibility of reception with the compressor switched on and off, and with various levels of the interfering noise. It is stated that the improvement obtained with the compressor switched on was equivalent to an increase of approximately 3 times in the maximum amplitude of the sound pressure from the loudspeaker.

2373. Experiments with a 5 Kilowatt High-Power Loudspeaker Installation on the Citadel at Nürnberg [using a Number of 150 Watt Loudspeakers: Good Audibility over 600 Metres Radius in spite of High General Noise Level: Some Results requiring Further Investigation].—O. Vierling. (*Akust. Zeitschr.*, March 1938, Vol. 3, No. 2, pp. 93–96.)

2374. Testing Public Address Equipment [Description of P.A. Amplifier, Methods of Testing, and Results].—P. H. Walker. (*Wireless World*, 7th April 1938, Vol. 42, pp. 302–305.)

2375. Triton: a Modern A.F. Amplifier Installation [9 Watts Output: for Broadcast Reception, Gramophone, P.A., etc: with Triple Loudspeakers]. — E. de Gruyter. (*Bull. Assoc. suisse des Élec.*, No. 5, Vol. 29, 1938, pp. 100–101.)

2376. Feeding Multiple Loudspeakers [with Varying Power Outputs]: an Ever-Present Sound-Reinforcement Problem.—(*Rad. Review of Australia*, Oct. 1937, Vol. 5, No. 10, pp. 285 and 292.)

2377. The Delta-Star [Speech-Input] Mixer.—J. N. A. Hawkins. (*Communications*, March 1938, Vol. 18, No. 3, pp. 20 and 35.)

2378. Low-Distortion Volume Expansion and Compression [coming into Action only at Pre-determined Level] using Negative Feedback.—Stevens. (*See* 2295.)

2379. Recent Developments in Hill-and-Dale Recorders [Uniform Response 30–12 000 c/s: Application of Regenerative Electromechanical Feedback].—L. Vieth & C. F. Wiebusch. (*Journ. Soc. Motion Pict. Eng.*, Jan. 1938, Vol. 30, pp. 96–104: *Bell Tel. Sys. Monograph* B-1047.)

2380. The Philips-Miller System of Sound Recording. — R. Vermeulen. (*Akust. Zeitschr.*, March 1938, Vol. 3, No. 2, pp. 65–73.) A summary was referred to in 2997 of 1937.

2381. Magnetic Sound Recording [Short Survey].—H. Weber. (*Bull. Assoc. suisse des Élec.*, No. 7, Vol. 29, 1938, pp. 148–151.)

2382. The London/Birmingham Coaxial Cable System: Part III—Layout of Equipment and Test Results.—A. H. Mumford. (*P.O. Elec. Eng. Journ.*, April 1938, Vol. 31, Part 1, pp. 51–56.)

2383. An Improved Method for obtaining Photographs of Ripple-Wave Actions [*e.g.* for Auditorium Models: Elimination of Surface-Tension Distortion].—M. E. Raquet & F. R. Watson. (*Journ. Acoust. Soc. Am.*, April 1938, Vol. 9, No. 4, pp. 352–353.)

2384. The Theoretical Derivations of the Laws of Reverberation.—H. & L. Cremer. (*Journ. Acoust. Soc. Am.*, April 1938, Vol. 9, No. 4, pp. 356–357.) Long summary of the German paper referred to in 1036 of March.

2385. On the Possibility of obtaining High Coefficients of Sound Absorption by using Systems of Resonators.—S. N. Rschevkin. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, No. 1, Vol. 18, 1938, pp. 25–30: in English.) *Cf.* Zeller, 1923 of May.

2386. On the "Sound Vases" of the Greek Tragedies and the Christian Churches.—P. Thielscher. (*Akust. Zeitschr.*, March 1938, Vol. 3, No. 2, pp. 85–92.)

2387. "Die physikalischen und technischen Grundlagen der Schalldämmung im Bauwesen" [Sound Insulation in Building: Book Review].—A. Schoch. (*Zeitschr. f. tech. Phys.*, No. 3, Vol. 19, 1938, p. 87.)

2388. "Lärm- und Erschütterungsabwehr im Hochbau" [Noise and Vibration Elimination in Large Buildings: Book Review].—W. Zeller (Edited by). (*Akust. Zeitschr.*, March 1938, Vol. 3, No. 2, p. 99.)

2389. On the Vibration Insulating by means of Springs and Damping Materials.—Meyer & Keidel. (*Journ. Acoust. Soc. Am.*, April 1938, Vol. 9, No. 4, pp. 355–356.) Summary of the German paper dealt with in 580 of February.

2390. Noise and Treatments for Its Reduction in Telephone Exchange Manual Switchrooms.—Stevens & Cullum. (*P.O. Elec. Eng. Journ.*, April 1938, Vol. 31, Part 1, pp. 57–61.)

2391. Noise-Preventing Installation of the International Telephone Exchange Room [Tokyo]. — Isida & Kobayashi. (*Nippon Elec. Comm. Eng.*, Feb. 1938, No. 9, pp. 90–91.)

2392. A Silence Room for Electrical Tests.—Paris Electric Company. (*Engineer*, 4th March 1938, Vol. 165, p. 255.) *See* also 196 of January.

2393. [Measurement of] Sound Absorption and Attenuation by the Flue Method.—H. O. Taylor & C. W. Sherwin. (*Journ. Acoust. Soc. Am.*, April 1938, Vol. 9, No. 4, pp. 331–335.)

2394. Background Noise Corrections [for Sound Measurements outside a Soundproof Room].—L. E. Packard. (*Communications*, March 1938, Vol. 18, No. 3, p. 24.)

2395. On a New Method of Measuring the Sound Fields in an Interior Room by means of a Continuous Spectrum [Highly Amplified Valve Noise: in connection with Loudspeaker Investigations, where the "Howling Note" Method is Unsatisfactory].—H. G. Freygang. (*Akust. Zeitschr.*, March 1938, Vol. 3, No. 2, pp. 80–84.)

2396. Sound and Vibration Measurement [Conference Summary].—P. L. Alger. (*Elec. Engineering*, March 1938, Vol. 57, No. 3, pp. 125–126.)

2397. [Measurement of] Absolute Sound Intensity in Liquids by Spherical Torsion Pendula [and the Calibration of Pressure Microphones].—E. Klein. (*Journ. Acoust. Soc. Am.*, April 1938, Vol. 9, No. 4, pp. 312–320.)

2398. Loudness, Masking, and Their Relation to the Hearing Process and the Problem of Noise Measurement.—H. Fletcher. (*Journ. Acoust. Soc. Am.*, April 1938, Vol. 9, No. 4, pp. 275–293.)

2399. The Physical Bases for the Construction of Apparatus for the Deaf, *and* Hearing Impairment and Sound Intensity.—P. Chavasse: M. B. Gardner. (*Ann. des Postes, T. et T.*, March 1938, Vol. 27, No. 3, pp. 210–226: *Bell Lab. Record*, March 1938, Vol. 16, No. 7, pp. 224–228.)

2400. Limits of Audition for Bone Conduction.—N. A. Watson. (*Journ. Acoust. Soc. Am.*, April 1938, Vol. 9, No. 4, pp. 294–300.)

2401. On the Measurement of the Absorption and Sensitivity Curves of the Human Ear [with Results on 12 Normal Subjects: Difficulties of the "Tube" Method of Absorption Measurement, and Their Elimination]. — R. Kurtz. (*Akust. Zeitschr.*, March 1938, Vol. 3, No. 2, pp. 74–79.) *Cf.* Waetzmann, 1936 of May.

2402. Distortion in the Ear as shown by the Electrical Responses of the Cochlea.—E. G. Wever & C. W. Bray. (*Journ. Acoust. Soc. Am.*, Jan. 1938, Vol. 9, No. 3, pp. 227–233.)

2403. Factors in the Production of Aural [Subjective] Harmonics and Combination Tones, *and* The Non-Linear Transmission Characteristics of the Auditory Ossicles. — Newman, Stevens, & Davis: Stuhlman. (*Journ. Acoust. Soc. Am.*, Oct. 1937, Vol. 9, No. 2, pp. 107–118: pp. 119–128.)

2404. The Nature of Fatigue in the Auditory System [Measurements on Decrease in Aural Sensitiveness caused by Exposure to Note of Known Frequency and Absolute Intensity: Results consistent with Resonance Theory of Hearing].—R. C. Parker. (*Proc. Phys. Soc.*, 1st Jan. 1938, Vol. 50, Part 1, No. 277, pp. 108–118.)

2405. The Sense of Hearing in Fish.—K. von Frisch. (*Nature*, 1st Jan. 1938, Vol. 141, pp. 8–11.)

2406. An Approach to the Study of Vocal Resonance [Attack on Cord-Tone-Resonance Theory of Vowels].—P. R. Farnsworth. (*Journ. Acoust. Soc. Am.*, Oct. 1937, Vol. 9, No. 2, pp. 152–155.)

2407. The Vibration of the Violin Bridge, *and* The Mechanical Action of Violins [with Frequency Curves of Valuable and Less Valuable Models].—Minnaert & Vlam: F. A. Saunders. (*Akust. Zeitschr.*, March 1938, Vol. 3, No. 2, p. 100: pp. 101–103: summaries only.)

2408. The Sound of Bells [and the Strike Note Problem].—J. Arts. (*Journ. Acoust. Soc. Am.*, April 1938, Vol. 9, No. 4, pp. 344–347.)

2409. Tones produced by a Wire placed in an Ignited Gas Jet.—J. J. Coop. (*Journ. Acoust. Soc. Am.*, April 1938, Vol. 9, No. 4, pp. 321–330.)

2410. A "Foaming Tone" obtained from Vibrating Strings and Rods.—T. Chung-Ling. (*Journ. Acoust. Soc. Am.*, April 1938, Vol. 9, No. 4, p. 354.)

2411. New Measurement of Velocity of Sound in Free Air [Discussion of Author's and Other Measurements suggests Probable Final Value of 330.8 m/sec. for Frequencies below 1000 c/s and 331.7 m/sec. for Higher Frequencies, in Dry Air at 0°].—T. J. Kukkamäki. (*Ann. der Physik*, March 1938, Vol. 31, No. 5, pp. 398–406.)

2412. Velocity and Ray Paths of Sound Waves in Sea Water.—O. W. Swainson. (*Hydrographic Review*, Nov. 1937, Vol. 14, No. 2, pp. 93–153.)

2413. Formulae for the Calculation of the Velocity of Sound and of the Temperature of Fusion.—R. Gianasso. (*Nuovo Cimento*, Dec. 1937, Vol. 14, No. 10, pp. 486–491.)

2414. The Velocity of Sound in Single Crystals of Bismuth [measured by a Method suitable for Small Specimens of Soft and Brittle Substances].—Focke & others. (*Journ. Acoust. Soc. Am.*, April 1938, Vol. 9, No. 4, pp. 348–351.)

2415. On the Determination of the Elastic Constants of Isotropic Solid Bodies with the Help of Supersonic Waves [and a Denunciation of Bez-Bardili's Theory and Results].—A. Walti. (*Helvetica Phys. Acta*, Fasc. 2, Vol. 11, 1938, pp. 113–139: in German.) *See* 226 of 1936.

2416. The Splitting-Up of the Rayleigh Line and the Acoustic Spectrum of Crystals.—E. Gross. (*Comptes Rendus* (*Doklady*) *de l'Ac. des Sci. de l'URSS*, No. 2, Vol. 18, 1938, pp. 93–94: in English.)

2417. Acoustic Vibrations and Internal Combustion Engine Performance: I—Standing Waves in the Intake Pipe System [Calculations on Usual Acoustic Theory: Check with Experimental Data for Single-Cylinder Engine].—Morse, Boden, & Schecter. (*Journ. of Applied Physics*, Jan. 1938, Vol. 9, No. 1, pp. 16–23.)

2418. Acoustics of the Combustion Chamber [Standing Waves accompanying Detonation in Cylinder of Internal Combustion Engine].—C. S. Draper. (*Phys. Review*, 1st Jan. 1938, Series 2, Vol. 53, No. 1, p. 108: abstract only.)

2419. The Generation of Supersonic Oscillations by Piezo-Quartz Lenses.—S. S. Tumanski. (*Journ. of Tech. Phys.* [in Russian], No. 20/21, Vol. 7, 1937, pp. 2049–2052.)

The method proposed by Gruetzmacher (225 of 1936) for obtaining converging supersonic waves by immersing in the liquid a valve-maintained oscillating curved quartz plate is investigated experimentally with the modification of using a lens-shaped crystal instead of a plate. Frequencies of 638.3 kc/s to 1000 kc/s were used, and the intensity of the vibrations was such that jets of oil 70 cm high were produced.

2420. A Powerful Magnetostrictive Supersonic Oscillator.—E. Ostrovski. (*Journ. of Tech. Phys.* [in Russian], No. 20/21, Vol. 7, 1937, pp. 2053–2060.)

A system has been developed in which a metal tube immersed in liquid is maintained in magnetostrictive oscillations by a valve oscillator. Frequencies of 9.4 to 40 kc/s were obtained and an experimental investigation was carried out on the effect of these oscillations (*e.g.* formation of emulsions and suspensions, corrosion of metals, etc.).

2421. An Improved Magnetostriction Oscillator, *also* Theoretical and Experimental Investigation of the Transmission of [Supersonic] Sound over Reflecting Surfaces [including Acoustic Mirage Effects due to Temperature Gradients], *and* Apparatus for Acoustic Research in the Supersonic Frequency Range.—G. W. Pierce & A. Noyes, Jr. (*Journ. Acoust. Soc. Am.*, Jan. 1938, Vol. 9, No. 3, pp. 185–192: pp. 193–204: pp. 205–211.)

2422. Sound Waves in a Moving Medium.—J. D. Trimmer. (*Journ. Acoust. Soc. Am.*, Oct. 1937, Vol. 9, No. 2, pp. 162–164.)

2423. New Method of Measuring the Velocity of Sound in Liquids by Capillary Supersonic Interference Systems.—J. P. Cance. (*Comptes Rendus*, 14th Feb. 1938, Vol. 206, No. 7, pp. 504–505.)

2424. Acoustic Resonance Spectra of Liquids [Water and Organic Liquids: Existence of Secondary Resonances].—C. Sălceanu & C. Istraty. (*Comptes Rendus*, 14th Feb. 1938, Vol. 206, No. 7, pp. 502–504.)

2425. The Supersonic-Wave Absorption in Liquids in the Frequency Range 50/80 Mc/s.—R. Bär. (*Helvet. Phys. Acta*, Fasc. 5, Vol. 10, 1937, pp. 332–337: in German.)

2426. On the Dispersion of Supersonic Waves in Liquids.—A. K. Dutta. (*Physik. Zeitschr.*, 1st March 1938, Vol. 39, No. 5, pp. 186–187.)

2427. Propagation of Supersonic Waves in Liquids—Dispersion in Some Pure Liquids and Aqueous Solutions: in Acetic Acid.—B. G. Spakovskij. (*Comptes Rendus* (*Doklady*) *de l'Ac. des Sci. de l'URSS*, No. 3, Vol. 18, 1938, pp. 169–175: in English.)

2428. New Properties of Birefringence of Liquids under the Influence of Supersonic Waves.—Lucas. (*See* 2472.)

2429. The Normal and Slanting Passage of a Plane Dilatation (Longitudinal) Wave, produced in a Liquid Medium, through a Fixed Plane-Parallel Plate in the Medium.—H. Reissner. (*Helvetica Phys. Acta*, Fasc. 2, Vol. 11, 1938, pp. 140–155: in German.)

2430. The Absorption of Supersonics in Smokes, *and* The Effect of Containing Tubes on Ultrasonic Velocities in Benzene.—Laidler & Richardson: Hulswit. (*Journ. Acoust. Soc. Am.*, Jan. 1938, Vol. 9, No. 3, pp. 217–223: pp. 224–226.)

2431. Charged Colloid Particles in an Ultrasonic Field [Theory: Potential Difference between Node and Antinode of Sonic Wave may be measurable and test Applicability of Debye's Theory].—J. J. Hermans. (*Phil. Mag.*, March 1938, Series 7, Vol. 25, No. 168, pp. 426–438.)

2432. Influence of a Magnetic Field on the Absorption of Sound in Oxygen Gas.—van Itterbeek & Thys. (*Physica*, April 1938, Vol. 5, No. 4, pp. 298–304: in English.)

2433. The Position of the Vibrator in the Experiments of Melde and Kundt.—B. J. Miller & L. O. Olsen. (*Journ. Accoust. Soc. Am.*, April 1938, Vol. 9, No. 4, pp. 341–343.)

2434. Ultrasonics and Supersonics [Classified Bibliography, to 1936].—H. Schecter. (*Electronics*, Jan. 1938, Vol. 11, No. 1, p. 34.)

2435. The [Giorgi] M.K.S. System of Units applied to Electroacoustics.—A. E. Kennelly & J. H. Cook. (*Journ. Acoust. Soc. Am.*, April 1938, Vol. 9, No. 4, pp. 336–340.)

2436. Radio Progress during 1937: Part I—Report by the Technical Committee on Electroacoustics.—(*Proc. Inst. Rad. Eng.*, March 1938, Vol. 26, No. 3, pp. 277–284.)

2437. Terminology of Acoustics: German Committee's Definitions.—(*Akust. Zeitschr.*, March 1938, Vol. 3, No. 2, pp. 110–111.)

PHOTOTELEGRAPHY AND TELEVISION

2438. A Theory of Noise for Electron Multipliers [Theoretical Treatment using only Elementary Assumptions and borrowing Methods only, not Results, from Previous Work on Shot Effect, etc: Correlation of Noise Properties of a Stage with Its Secondary-Emission Properties: Extension to Multi-Stage Multipliers].—W. Shockley & J. R. Pierce. (*Proc. Inst. Rad. Eng.*, March 1938, Vol. 26, No. 3, pp. 321–332.)

2439. The Wave-Slot, an Optical Television System.—F. von Okolicsanyi. (*Funktech. Monatshefte*, March 1938, No. 3, Supp. pp. 17–22.) From the *Wireless Engineer* article, 593 of February.

2440. A New Optical Method of Television Reception: a System which dispenses with Scanning Devices [Scophony "Flash-Light" and "Two-Cell" (Stroboscopic Wave-and-Slot) Methods].—F. Okolicsanyi. (*Television*, Feb. 1938, Vol. 11, No. 120, pp. 69–70.) *See* also 2439, above.

2441. A New Principle for the Electron Scanning of the Images in Television ["Dispersive Field" Modification of Farnsworth Method].—J. Loeb. (*L'Onde Élec.*, March 1938, Vol. 17, No. 195, pp. 128–134.) Paper read before the Société des Radioélectriciens; a summary was dealt with in 1072 of March.

2442. A New System of Large-Screen Projection [Image Retention, with Controlled Black-Out, by Externally Sustained Reciprocal Secondary Emission between Fluorescent Screen and Gauze Screen (with High Secondary Emission) close to It.]—E. P. Rudkin. (*Television*, Feb. 1938, Vol. 11, No. 120, pp. 96–99 and 126, 127.) For corrections see *ibid.*, March, No. 121, p. 191. For a different plan *see* 2443, below.

2443. Picture Retention [for Increased Brightness and Freedom from Flicker: by Mosaic of Small Metallic Elements separated by Insulating Material, close to Illuminated Photoemissive Surface: Electron Image projected on to Fluorescent Screen].—T. de Nemes. (*Television*, April 1938, Vol. 11, No. 122, p. 205.) From the Hungarian Post Office laboratories.

2444. The Manufacture of the "Safar" Cathode-Ray Tubes for Oscillography and Television.—Castellani. (*Televisione*, Rome, Feb. 1938, Vol. 2, No. 4, pp. 177–189: concluded.)

2445. Correction to Diagram in "Method for Judging the Linearity with Time, and the Fly-Back Velocity, of the Ray Deflection in Cathode-Ray Tubes."—H. Bödeker. (*Funktech. Monatshefte*, March 1938, No. 3, Supp. p. 23.) *See* 1951 of May.

2446. World's Largest Cathode-Ray Tube [18 inches × 24 inches Picture Too Bright for Darkened Room: Welded Steel Cone, 2 inches Thick Glass End].—I. G. Maloff. (*Television*, April 1938, Vol. 11, p. 203.)

2447. Further Notes on the Possibilities of Small Tubes [particularly the Mullard A41/B4 or G4: "Excellent Pictures up to 35 Miles"].—S. West. (*Television*, Feb. 1938, Vol. 11, No. 120, pp. 77–78 and 81.)

2448. The Phasmajector [Source of Video Signals for Testing].—Du Mont Laboratories. (*Television*, April 1938, Vol. 11, No. 122, p. 196.) *Cf.* Wilder, 1953 of May.

2449. Testing Electron Lenses [BT-H Device for Measurement of Aberrations].—D. Gabor. (*Television*, April 1938, Vol. 11, p. 206.)

2450. Control of the Phase of Synchronised Relaxation Oscillations (Time-Bases) [Circuits for shifting Phase by Steps of One Cycle of the Synchronising Frequency: Continuous Adjustment only possible by Phase-Changing Circuits on Synchronising Input].—E. Hudec. (*E.N.T.*, Feb. 1938, Vol. 15, No. 2, pp. 29–35.)

2451. A New Time Base [Modification of " Squegging " Oscillator: a Hard-Valve Circuit with Linear Characteristics].—D. G. Reid. (*Wireless World*, 14th April 1938, Vol. 42, pp. 334–336.)

2452. A Transportable Television Installation [for Demonstration of Transmission and Reception].—J. van der Mark. (*Philips Tech. Review*, Jan. 1938, Vol. 3, No. 1, pp. 1–4.)

2453. Television Relay Systems [Examination of Possibility of Wired Relaying as in Sound Broadcasting: Impracticable in Present State of Knowledge].—(*Wireless World*, 7th April 1938, Vol. 42, pp. 309–310.)

2454. The Construction of Television Receivers: Basic Circuit Details and a Preliminary Outline of Two Experimental Models.—M. P. Wilder. (*QST*, April 1938, Vol. 22, pp. 23–27.)

2455. Finding and Remedying Television Receiver Faults.—S. West. (*Television*, Feb., March, & April 1938, Vol. 11, Nos. 120–122, pp. 91–93; 162 & 189, 192; 225.)

2456. Radio Amateurs will attack Home Television Problem.—(*Sci. News Letter*, 2nd April 1938, Vol. 33, pp. 211–212.)

2457. Radio Progress during 1937: Parts II & IV—Report by the Technical Committee on Electronics: on Television and Facsimile.—(*Proc. Inst. Rad. Eng.*, March 1938, Vol. 26, No. 3, pp. 285–290: pp. 298–301.)

2458. Progress in Television Technique in the Year 1937.—F. Banneitz & F. Ring. (*Funktech. Monatshefte*, March 1938, No. 3, pp. 22–23.)

2459. Baird Colour Television [Dominion Theatre Demonstration].—(*Television*, March 1938, Vol. 11, No. 121, pp. 151–152.)

2460. British and German Television, and the Paris International Exposition.—Marsland Gander. (*Television*, Feb. 1938, Vol. 11, No. 120, p. 76.)

2461. The Special Television Exhibit at the " German Museum " in Munich.—F. Fuchs. (*Rad., B., F. für Alle*, Oct. 1937, No. 188, pp. 145–150.)

2462. A Transmitter for Television Experiments [General Design Considerations (including Advantages of Pentodes) and the Philips Transmitter].—W. Albricht. (*Philips Transmitting News*, Sept. 1937, Vol. 4, No. 4, pp. 13–23: in German & English concurrently.)

2463. " Fernsehen " [Book Review].—F. Schröter (Edited by). (*Television*, Feb. 1938, Vol. 11, No. 120, p. 93.)

2464. " Televisie."—B. van der Pol. (At Patent Office Library, London; Cat. No. 78 198: 12 pp.)

2465. New Receiving Tubes: Type 1851 Television Tube [Amplifier Pentode with Very High Grid/Plate Transconductance].—RCA. (*QST*, April 1938, Vol. 22, p. 98.)

2466. Inductively Compensated Tetrode Amplifiers.—Johnstone. (*See* 2241.)

2467. Discussion on " Coaxial Cables."—E. M. Deloraine. (*Bull. de la Soc. franç. des Élec.*, March 1938, Vol. 8, No. 87, pp. 203–226 and 242–255.) *See* 1101 of March.

2468. The Transmission of Wide Frequency Bands along Cables [Theory of Coaxial Cable: the Symmetrical Cable: Attenuation Measurement: etc.].—G. Straimer. (*Funktech. Monatshefte*, March 1938, No. 3, pp. 80–82.) Concluded from 1972 of May.

2469. Theory of Cylindrical Dielectric Cables, and Relations with the Theory of Coaxial Cables.—Clavier. (*See* 2174.)

2470. The London/Birmingham Coaxial Cable System: Part III—Layout of Equipment and Test Results.—A. H. Mumford. (*P.O. Elec. Eng. Journ.*, April 1938, Vol. 31, Part 1, pp. 51-56.)

2471. Colloidal-Graphite Light-Relays [Account of Investigations on " Oildag "].—A. H. Stuart: Stevens. (*Television*, April 1938, Vol. 11, No. 122, pp. 204–205.) Prompted by Stevens's article (1086 of March) and a Baird patent.

2472. New Properties of Birefringence of Liquids under the Influence of Supersonic Waves [Plane-Polarised Light passed through the Liquid between Crossed Nicols: Light restored on exciting Liquid by Piezoelectric Plate: Maximum Effect with Principal Sections of Nicols at 45° to Direction of Propagation of Supersonic Waves].—R. Lucas. (*Comptes Rendus*, 14th March 1938, Vol. 206, No. 11, pp. 827–828.)

2473. Sensation Level and Intensity Level of Light [and Their Relation: Brightness may well be expressed in Decibels: Ear 60 db More Sensitive than Eye: etc.]—M. Katsumi. (*Nippon Elec. Comm. Eng.*, Feb. 1938, No. 9, pp. 92–93.)

2474. G.E.C. Secondary-Emission Photocells [" Cathode-on-Wall " Types CWS24 and CWS8].—(*Television*, April 1938, Vol. 11, No. 122, p. 224.)

2475. Selenium [Barrier-Layer] Photoelements and Their Employment [Five Distinct Types, differing chiefly in Internal Resistance: Table of Data: Latest Type (with Lowest Resistance) free from Fatigue within 0.3%: Ageing: Table showing Suitable Types for Various Applications: Faults and Their Elimination].—W. Behrendt. (*Zeitschr. f. tech. Phys.*, No. 4, Vol. 19, 1938, pp. 92–97.)

2476. A Grating Monochromator [for Photoelectric Research] for the Schumann Region.—R. F. Baker. (*Journ. Opt. Soc. Am.*, March 1938, Vol. 28, No. 3, pp. 55–60.)

2477. Friction of Rotating Discs.—G. G. McDonald. (*Engineer*, 4th March 1938, Vol. 165, p. 248.)

2478. Three-Colour Picturegrams: American Inventor's Achievements [" Telechrome " System].—W. G. H. Finch. (*Rad. Review of Australia*, Nov. 1937, Vol. 5, No. 11, pp. 316 and 317.)

MEASUREMENTS AND STANDARDS

2479. YT-Cut Quartz Plates [with Very Small Temperature Coefficient: Suitable for Short and Ultra-Short Waves].—H. Yoda. (*Electrot. Journ.*, Tokyo, April 1938, Vol. 2, No. 4, p. 96.) A plate 0.04 × 20 × 20 mm^3 gave a fundamental wavelength of 4.7 m.

2480. " Sectional Oscillation " of Very Thin Quartz Plates for Ultra-Short Waves.—Uda, Honda, & Watanabe. (*See* 2268.)

2481. On the Variety of Vibratory States of a Hollow Cylinder of Quartz.—Ny Tsi-Zé & C. Ming-San. (*Journ. de Phys. et le Radium*, Feb. 1938, Vol. 9, No. 2, pp. 52–56 and Plate.) A summary was dealt with in 1588 of April.

2482. " Notation for Piezoelectric Quartz " [Notice of Pamphlet].—National Physical Laboratory. (*Electrician*, 25th March 1938, Vol. 120, p. 375.)

2483. Periods of Longitudinal Vibration of Steel Cones and Truncated Cones [excited by Magnetostriction].—G. W. Pierce & A. Noyes, Jr. (*Journ. Acoust. Soc. Am.*, April 1938, Vol. 9, No. 4, pp. 301–307.)

2484. A Simple Wavemeter for the Frequency Range 3 to 60 Mc/s [with Double-Diode and Compensation for Current of Repose].—K. Herold. (*Funktech. Monatshefte*, March 1938, No. 3, pp. 70–72.)

2485. On the Absolute Measurement of Alternating Currents and the Calibration of Thermocouples in the Decimetre-Wave-Range up to 500 Mc/s.—M. J. O. Strutt & K. S. Knol. (*Physica*, April 1938, Vol. 5, No. 4, pp. 205–214: in English.)

Down to 5 m or rather smaller wavelengths, thermocouples can be calibrated absolutely by comparison with the values given by special diode (acorn-valve) voltmeters measuring the volts (within 1%) across a known impedance (calculated within 1%). For wavelengths down to 60 cm they can be calibrated by the hot-wire air thermometer described by Scheibe in 1925, using a thin constantan wire in air in a tube of polystyrol (which has a very low heat conductivity): two such tubes are used, to form a compensation arrangement with a water drop in a capillary tube as a balance indicator. Equality of current in thermocouple and air thermometer is obtained by a Lecher-wire bridge circuit. Two special types of thermocouple are described.

2486. A Method of measuring Minute Radio-Frequency Alternating Current, and Its Application to the Absolute Measurement of Field Strengths of Weak Radio Signals [Modification of Martyn's Filament-Current Procedure: Accurate Measurement of R.F. Currents of 10^{-6} Ampere: Examples on Weak Broadcast Signals: Calculation of Austin-Cohen Coefficient].—Imam, Gangopadhyaya, & Khastgir. (*Indian Journ. of Phys.*, Jan. 1938, Vol. 11, Part 6, pp. 361–375.)

2487. A New Current and Voltage Meter for Measurements up to 1 Mc/s in Communication Engineering.—Thilo & Bidlingmaier. (*E.T.Z.*, 7th April 1938, Vol. 59, No. 14, p. 378: summary only.)

2488. An Inverse Valve Voltmeter [giving Direct Readings 10–20 000 Volts without Appreciable Current Drain: using Inverse Characteristics of Triode].—O. H. Schmitt. (*Journ. Scient. Instr.*, April 1938, Vol. 15, No. 4, pp. 136–137.) " The inverse amplification factor μ^{-1} and the inverse mutual inductance M_g^{-1} are two characteristics of the ordinary triode valve which are perhaps unduly neglected."

2489. The Employment of a Triode as Electrometer for Voltages of the Order of 1000 Volts.—E. Huguenard. (*L'Onde Elec.*, Feb. 1938, Vol. 17, No. 194, pp. 100–101.)

A tension of some tens or hundreds of volts is established between grid and cathode, the grid being positive. The grid current, suitably limited by a resistance, is measured by a milliammeter. The voltage to be measured is applied between cathode and plate, the latter being negative. The field thus produced hinders the electrons emitted by the cathode from reaching the grid, and reduces the grid current, whose decrease gives a measure of the required voltage. The writer uses a Philips " horned " triode TCO3/5. Voltages between 0 and 1500 volts can be measured merely by changing the grid voltage in steps from 40 to 160 volts.

2490. Opposition Methods for the Measurement of Alternating Voltages [Small Powers, in Amplitude and Phase: Precision Method for Laboratory, using Hot Wire & Thermoelements, and a Carefully Stabilised Motor-Generator Set as A.C. Standard.]—W. Oesinghaus. (*Rev. Gén. de l'Élec.*, 19th Feb. 1938, Vol. 43, No. 8, p. 242: long summary only.)

2491. Sharp Cut-Off in Vacuum Tubes, with Applications to the Slide-Back Voltmeter [Methods of Increasing the Coefficient *k* in the Exponential Law holding near Cut-Off: etc.].—C. B. Aiken & L. C. Birdsall. (*Elec. Engineering*, April 1938, Vol. 57, No. 4, Supp. pp. 171–176.)

2492. A Valve-Voltmeter with Retroactive Direct-Voltage Amplification [for Measurement of Direct-Voltage Changes down to a Millivolt, Direct-Current Changes down to a Millimicroampere, R.F. Voltages down to 25 Millivolts: Combining High Sensitivity obtainable from Valve Circuits with "Reliability and Stability of Ordinary D.C. Components and Instruments"].—F. M. Colebrook. (*Wireless Engineer*, March 1938, Vol. 15, No. 174, pp. 138–142.)

2493. Phase-Shift Measurement [Push-Pull Circuit with Diode Voltmeter for measuring Amplifier Gain and Phase-Shift].—S. Zienau. (*Wireless World*, 14th April 1938, Vol. 42, pp. 329-330.)

2494. Compensation Method for the Measurement of Small Reactances forming Part of a High-Resistance Circuit [More Sensitive than the Maxwell Method].—J. Listray. (*Rev. Gén. de l'Élec.*, 12th March 1938, Vol. 43, No. 11, pp. 334–335.)

2495. An Apparatus for the Determination of Small Loss Angles at High Frequency [by the Detuning Method: Direct Reading: Mains Operated: Applicable also to Measurement of Self-Capacity of Coils or Self-Inductance of Condensers].—A. Agricola. (*Hochf:tech. u. Elek:akus.*, March 1938, Vol. 51, No. 3, pp. 77–87.) "It has been found that with the apparatus technical measurements in the range from 50 to 10 000 kc/s can be made comparatively quickly with the accuracy of precision methods."

2496. Measurement of Dielectric Losses at High Frequencies [up to 10 Mc/s] by the Substitution Method.—Akahira & others. (*Electrot. Journ.*, Tokyo, April 1938, Vol. 2, No. 4, p. 95.) Short description of the "symmetrical substitution circuit" apparatus dealt with in 1561 of April. Some results are given on various dielectrics, including Terex, Lawrex, and Ambroid. In some cases the special h.f. resistance with parallel plate terminals (*see* 1791 of May) was used.

2497. Method for the Measurement of Small Capacities at Industrial Frequencies [Substitution Method using Capacity Potential Divider in parallel with Electrodes of Triode: Accuracy 2% for Range from One to Several Thousand Micromicrofarads].—C. Pistoia. (*Alta Frequenza*, April 1938, Vol. 7, No. 4, pp. 245–257.)

2498. A Note on the Calibration of Decade Condensers [by Schering Bridge, but avoiding Usual Need for Large Range of Substandard Condensers or of Resistance Ratios].—L. H. Ford & N. F. Astbury. (*Journ. Scient. Instr.*, April 1938, Vol. 15, No. 4, pp. 122–126.)

2499. The Calculation of the Inductance of Coils with Ferrocart and Sirufer Cores.—(*Rad., B., F. für Alle*, Feb. 1938, No. 192, Supp. pp. 9–10.)

2500. Discussion on "Numerical Determinations of Inductances, and Their Application to the Dispersion of Transformers." P. Bunet. (*Bull. de la Soc. franç. des Élec.*, Feb. 1938, Vol. 8, No. 86, pp. 114–119.) *See* 1117 of March.

2501. A New Instrument for testing Coils.—T. M. Dickinson. (*Gen. Elec. Review*, April 1938, Vol. 41, No. 4, pp. 199–201.)

2502. On the Ninth "Cycle of Measurement" [of the A.E.I: Measurements of Equivalent Resistance and Resonance Coefficient of an Oscillatory Circuit, by Wattmeter Method and by Voltmeter/Ammeter Method, both using Thermojunction Converters].—G. Maione. (*L'Elettrotec.*, 10th March 1938, Vol. 25, No. 5, pp. 148–149.) Further details on the tests dealt with in 4233 of 1937.

2503. The "Philoscope" [Mains-Driven Bridge of Many Applications, with "Magic Eye" as Balance Indicator].—Philips Company. (*Rad., B., F. für Alle*, Feb. 1938, No. 192, pp. 26–28.)

2504. The Behaviour of the Symmetrical Wheatstone Bridge in the "Deflection" Method [as opposed to the "Null" Method].—K. Melzer. (*Elektrot. u. Masch: bau*, No. 12, Vol. 56, 1938, pp. 156–160.)

2505. Measurement of Grid Currents in Thermionic Valves.—Wilcox. (*See* 2340.)

2506. Selectivity Measurements on Broadcast Receiving Apparatus, *and* Standardisation of Tests on Broadcast & Other Receivers.—Weijers: Société des Radioélectriciens. (*See* 2299 & 2300.)

2507. "Measurements in Radio Engineering" [Book Review].—F. E. Terman. (*P.O. Elec. Eng. Journ.*, April 1938, Vol. 31, Part 1, p. 79.)

2508. "Electrical Measurements: 2nd Edition" [Book Review].—F. A. Laws. (*Electrician*, 25th March 1938, Vol. 120, p. 384.)

2509. The Testing of Sensitive A-C Pointer Instruments by Null Methods.—W. Hohle & W. Rump. (*Physik. Zeitschr.*, 1st March 1938, Vol. 39, No. 5, pp. 169–173.)

2510. A Simple Plan for the Parallax-Free Reading of Pointer Instruments [Pointer moves *between* Mirror and Scale].—Bumann & Ritzow. (*Zeitschr. f. tech. Phys.*, No. 4, Vol. 19, 1938, pp. 97–98.)

SUBSIDIARY APPARATUS AND MATERIALS

2511. On the Rectification Effect in Gas-Focused Cathode-Ray Oscillograph.—Rabinovich. (*Izvestiya Elektroprom. Slab. Toka*, No. 12, 1937, pp. 56–60.)

In low-voltage gas-focused cathode-ray oscillographs a rectification effect may take place in the deflecting-plates circuit owing to the ionisation of the gas by the electron ray. A rectified voltage may therefore appear at the deflecting plates and the electron ray will receive a steady deflection. In the present paper a family of curves is plotted for a particular type of oscillograph showing the relationship between the rectified current and rectified voltage for various values of the applied voltage, and the rectification effect is discussed for the cases (a) when one of the deflecting plates is disconnected, (b) when a sinusoidal voltage is applied to the tube, and (c) when the tube is connected to a relaxation oscillator. In conclusion, compensation of the rectification effect by means of a resistance connected in parallel with the deflecting plates is considered.

2512. A Method of Measuring Short Time Intervals [Operating Time of Relays, etc: Principle and Circuit of Spiral-Track C-R Oscillograph: Time Interval (controlling Start and Stop of Oscillations) measured by Angular Distance of Track].—Kuroda, Takahasi, & Tusina. (*Nippon Elec. Comm. Eng.*, Feb. 1938, No. 9, pp. 93–94.) *Cf.* Dowling & Bullen, 1577 of 1936.

2513. The Recording of Transient Electrical Phenomena of Rapid Decay by the Cathode-Ray Oscillograph.—Angelini. (*Rev. Gén. de l'Élec.*, 9th April 1938, Vol. 43, No. 15, pp. 456–458: long French summary of the Italian paper dealt with in 2337 of 1937.)

2514. Recurrent-Surge Oscillographs: Their Application to Short-Time Transient Phenomena [and an Equipment for Recurrence Frequency of about 1000 c/s giving Adequate Brilliancy with Time-Scale Velocity of 30 mm/μsec.].—Wilkinson. (*BT-H Activities*, March/April 1938, Vol. 14, No. 2, pp. 45–54.)

2515. A Note on the Photographic Engraving of Scales on Cathode-Ray Tubes [Process giving Scales fully Opaque on Transparent Background: Parallax Errors reduced to Minimum: Slight Irregularities in Tube End automatically Compensated].—Walker. (*Marconi Review*, April/June 1938, No. 69, pp. 37–41.)

2516. Cathode-Ray Electron Ballistics [and a General Deflection-Sensitivity Correction Chart].—Gager. (*Communications*, March 1938, Vol. 18, No. 3, pp. 10–11 and 15, 28.)

2517. The Electron Telescope [Principles, Development, and Applications].—S. Malatesta. (*L'Elettrotec.*, 25th March 1938, Vol. 25, No. 6, pp. 188–190.) Based chiefly on the work of Holst, de Boer, Coeterier & others (1045 of 1937 & back reference) and of Zworykin & Morton (1576, 2354 & 3492 of 1936).

2518. Electron-Optical Observation of Metal Surfaces: III & IV [Zirconium: Nickel-Iron Crystals, Appearance of "Lines" of High Emissivity].—Burgers & van Amstel. (*Physica*, April 1938, Vol. 5, No. 4, pp. 305–312 & 313–319.)

2519. A New Time Base [Modification of "Squegging" Oscillator: a Hard-Valve Circuit with Linear Characteristics].—Reid. (*Wireless World*, 14th April 1938, Vol. 42, pp. 334–336.)

2520. Papers on Cathode-Ray Tubes, Time Bases, Electron Optics.—(*See* also under "Phototelegraphy & Television.")

2521. An Exposure Meter for Cathode-Ray Oscillographs.—RCA. (*Television*, March 1938, Vol. 11, No. 121, pp. 138–139.)

2522. Modifications of the Glow of a Phosphorescent Zinc Sulphide under the Influence of an Electric Current.—Déchêne. (*Journ. de Phys. et le Radium*, March 1938, Vol. 9, No. 3, pp. 109–119.)

2523. High-Frequency Modulation of Light by Supersonic Waves, and the Development of a New Type of Flurometer [for the Measurement of Decay Times of Fluorescent Materials].—O. Maercks. (*Angewandte Chemie*, 19th March 1938, Vol. 51, No. 11, p. 163: summary only.) A German Physical Society paper.

2524. Note on a Vacuum-Tight Seal for Electrodes with High Insulation [for Electrometers, etc.].—Bradfield. (*Canadian Journ. of Res.*, March 1938, Vol. 16, No. 3, Sec. A, p. 76.) Ebonite pressed up against a brass shoulder with a small annular groove.

2525. A New Method of Synchronisation in the Recording of Electrical Processes by an Oscillograph [by Difference of Motion of Falling Bars of Solenoid Magnets].—Balygin. (*Automatics & Telemechanics* [in Russian], No. 4, 1937, pp. 67–70.)

2526. Description of an Apparatus for Photographic Recording: Photometric Method for the Recording of Rapidly Varying Electric Currents [by Variable-Density "Sound-on-Film" Lamp and Microphotometric Interpretation, giving Curves identical with Cathode-Ray Oscillograms].—Fortrat & Dupuy. (*Journ. de Phys. et le Radium*, Feb. 1938, Vol. 9, No. 2, Supp. pp. 19–20 S.)

2527. Selenium Rectifiers [and Their Increasing Application].—(*Communications*, March 1938, Vol. 18, No. 3, pp. 7–9.)

2528. Researches on the Electrical Conductivity of Cuprous Oxide [Composition and Structure: Effects of Heat Treatments and of Impurities: Adsorbed Oxygen acts on Surface Conductivity in Same Way that Dissolved Oxygen increases Volume Conductivity: etc.].—Dubar. (*Ann. de Physique*, Jan. 1938, Series 11, Vol. 9, pp. 5–104.)

2529. Resistance Measurements on Cuprous Oxide at High Field Strengths [Resistance found to be Independent of Field Strength up to 90 kV/cm].—Henninger. (*Physik. Zeitschr.*, 15th March 1938, Vol. 39, No. 6, pp. 216–224.)

2430. On the Capacity at the Contact of a Metal & a Semiconductor [Measurements by applying Voltage & studying Growth of Current by Cathode-Ray Oscillograph: Application to Theory of Copper-Oxide/Copper Contacts].—Déchêne. (*Comptes Rendus*, 14th March 1938, Vol. 206, No. 11, pp. 828–830.)

2531. Electrical Conductivity [Short Survey of Recent Work on Metallic and Non-Metallic Substances].—Percival. (*BEAMA Journal*, March 1938, Vol. 42, No. 9, pp. 84–86.)

2532. Aluminium Alloy Structural Materials.—Farmer. (*Bell Lab. Record*, Jan. 1938, Vol. 16, No. 5, pp. 164-166.)

2533. The Materials of Precision Mechanical Technique.—Franz. (*Zeitschr. V.D.I.*, 18th Dec. 1937, Vol. 81, No. 51, pp. 1449–1452.)

2534. Recent Developments in Tantalum and Columbium [and the Use of the Former for Valves and Electrolytic Condensers].—Balke. (*Indust. & Eng. Chemistry*, March 1938, Vol. 30, No. 3, pp. 251–254.)

2535. The Modern Electrolytic Condenser [and the Progress in the Last Two Years].—Oburger. (*Elektrot. u. Masch:bau*, 3rd April 1938, Vol. 56, No. 14, pp. 179–183.)

2536. The Dielectric Properties of Insulating Materials.—Murphy & Morgan. (*Bell S. Tech. Journ.*, Oct. 1937, Vol. 16, No. 4, pp. 493–512.) Physico-chemical interpretation of the dielectric constant: electronic, atomic, and Debye orientational polarisations: frequency and temperature dependence of dielectric constant. A qualitative treatment, to be followed by a more quantitative paper.

2537. The Development of the Manufacture of "Presspan" ["Pressboard," "Transformerboard"].—Tschudi. (*Bull. Assoc. suisse des Élec.*, No. 7, Vol. 29, 1938, pp. 144–147.)

2538. Surface Breakdown of Mica [Experimental Results].—Saito. (*Electrot. Journ.*, Tokyo, April 1938, Vol. 2, No. 4, p. 96.)

2539. Effect of Mechanical Stress on the Dielectric Breakdown of Crystal [Experimental Investigation and Deductions regarding Movement of Electrons at Time of Breakdown].—Saito. (*Electrot. Journ.*, Tokyo, April 1938, Vol. 2, No. 4, pp. 87–91.)

2540. Plastics and Electrical Insulation.—Hartshorn, Megson, & Rushton. (*Electrician*, 25th March 1938, Vol. 120, p. 380: summary of I.E.E./Soc. Chem. Ind. paper). For the subsequent Discussion see *ibid.*, 1st April, p. 420.

2541. "Philite" [of Various Kinds, including "Transphilite" and "Philitax"] as a Structural Material.—Polis. (*Philips Tech. Review*, Jan. 1938, Vol. 3, No. 1, pp. 9–16.)

2542. Breakdown of Compressed Nitrogen in Small Gaps.—Goldman. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, No. 2, Vol. 18, 1938, pp. 89–92: in English.)

2543. Insulating Varnishes in Electrical Construction.—Balvay. (*Rev. Gén. de l'Élec.*, 12th Feb. 1938, Vol. 43, No. 7, pp. 223–224.)

2544. Dielectric Losses in Polar Liquids and Solids [and the Relations between Chemical Composition and Dipole Loss].—Morgan. (*Indust. & Eng. Chemistry*, March 1938, Vol. 30, No. 3, pp. 273–279.)

2545. Porcelain Cable [as Substitute for Lead-Covered].—Ziegler. (*Bull. Assoc. suisse des Élec.*, No. 6, Vol. 29, 1938, p. 117: summary only.)

2546. Incombustible Electric Conductors ["Pyrotenax" Wires and Cables]—Bethenod. (*Bull. de la Soc. franç. des Élec.*, April 1938, Vol. 8, No. 88, pp. 325–340.)

2547. Simple Circuit for Generator-Voltage Stabilisation [Field excited by Accumulator Battery opposed by Auxiliary D.C. Generator driven at Same Speed as Main Generator].—Kirkpatrick & Harworth. (*Review Scient. Instr.*, Nov. 1937, Vol. 8, No. 11, pp. 430–431.)

2548. The Saturated-Choke Voltage Stabiliser.—Sazanov. (*Izvestiya Elektroprom. Slab. Toka*, No. 12, 1937, pp. 30–37.)

The Raytheon voltage stabiliser is discussed. An equivalent circuit is shown (Fig. 1) and a vector diagram is drawn of voltages and currents in the stabiliser (Fig. 2). The operation is discussed, in particular the following points: the maximum permissible decrease and increase in the applied voltage; the stability, efficiency, and power factor of the stabiliser; and the effect of the load on its operation. Some oscillograms are included, showing the variation of the stabilised voltage when the applied voltage is varied, and also experimental curves taken with a 150 VA stabiliser built in the U.S.S.R. Methods are also indicated for designing and tuning the stabiliser, and some practical suggestions are made with regard to its construction.

2549. Voltage Stabiliser: Preventing Fluctuations in HT Supply.—Taylor. (*See* 2290.)

2550. Effect of Ripple Voltages on Automatic Voltage Control of D.C. Generator by Vacuum Tubes.—Awaya & others. (*Electrot. Journ.*, Tokyo, Jan. 1938, Vol. 2, No. 1, pp. 6–10.)

2551. Tests on "Starto" Tubes [Automatic Starting Resistances with Negative Temperature Coefficients].—Ansaloni & Giardino: Philips Company. (*L'Elettrotec.*, 10th March 1938, Vol. 25, No. 5, pp. 146–148.)

2552. A Transportable Generator for 5000 Volts D.C. [designed for Cable Testing].—Foretay. (*Bull. Assoc. suisse des Élec.*, No. 4, Vol. 29, 1938, pp. 76–78.)

2553. Vibratory H.T. Generators [chiefly American].—(*Wireless World*, 31st March 1938, Vol. 42, pp. 293–294.)

2554. Processes occurring in Fuses subjected to Electric Surges [due to Lightning Strokes, etc.].—Wrana. (*E.T.Z.*, 6th Jan. 1938, Vol. 59, No. 1, pp. 11–13.)

2555. Magnetic Fields in Transformers at Low Frequencies—25 to 75 c/s [Theory giving Formulae for Certain Types].—Thomson. (*Phil. Mag.*, Feb. 1938, Series 7, Vol. 25, No. 167, pp. 242–256.)

2556. The Calculation of the Efficiency, Losses, and Heating-Up of Small Mains Transformers.—Wigand. (*Rad., B., F. für Alle*, March 1938, No. 193, pp. 33–38.)

2557. Electro-Magnet with Constant Pull over a Large Stroke [" Ring " Magnet].—Traenkle. (*E.T.Z.*, 7th April 1938, Vol. 59, No. 14, p. 371: summary only.)

2558. Field-Strength Meter for Permanent Magnets [Rotating Disc Principle].—Schneider Company. (*E.T.Z.*, 10th March 1938, Vol. 59, No. 10, p. 274.)

2559. Higher Magnetic Permeabilities [Single Crystal of Permalloy (with 66% Nickel), Specially Treated, gives Permeability of 1 330 000: Possible Commercial Use of Heat Treatment in Hydrogen at High, and in Magnetic Field at Relatively Low, Temperatures].—Bozorth. (*Bell Lab. Record*, March 1938, Vol. 16, No. 7, pp. 229–231.)

2560. Order-Disorder Transformations by Alloys [Survey, including Relation to Magnetic Properties].—Nix & Shockley. (*Reviews of Modern Phys.*, Jan. 1938, Vol. 10, No. 1, pp. 1–71.)

2561. Paramagnetism of the Iron Group [Experimental Investigation of Magnetic Properties of Organic Cobalt and Nickel Salts].—Bhatnagar, Khanna, & Nevgi. (*Phil. Mag.*, Feb. 1938, Series 7, Vol. 25, No. 167, pp. 234–241.

2562. Magnetic Properties and Chemical Constitution of Iron Oxides and Magnetites.—Hillpert. (*Angewandte Chemie*, 19th March 1938, Vol. 51, No. 11, p. 163: summary only.)

2563. Effect of Magnetic Transformations on the Velocity of Formation of Ferrites [Increased Velocity in Neighbourhood of Curie Point].—Forestier & Lille. (*Comptes Rendus*, 8th Nov. 1937, Vol. 205, No. 19, pp. 848–850.)

2564. Manganferrites: Papers on Their Electrical Behaviour, Dielectric Properties, and Ferromagnetism & Structure.—Schulze & others. (*Physik. Zeitschr.*, 15th March 1938, Vol. 39, No. 6, pp. 205–216.)

2565. On Magnetic Anisotropy in Ferromagnetic Crystals in Weak Fields [Remarks on Williams's Paper].—Kondorsky: Williams. (*Comptes Rendus* (*Doklady*) *de l'Ac. des Sci. de l'URSS*, No. 6, Vol. 18, 1938, pp. 325–327.)

2566. The Temporal Course of the Magnetisation Process in Weak Fields [Experimental Results: Mathematical Expression], *and* Comparative Remarks on the Papers by Richter and Wittke on Magnetic After-Effect [Richter's Measurements fall in with Wittke's Theory].—Wittke. (*Ann. der Physik*, Series 5, No. 2, Vol. 31, 1938, pp. 97–115: pp. 187–192.) *See* 1219 & 4325 of 1937.

2567. Coupling between the Orbital and the Spin Angular Momenta of Paramagnetic Ions from Magnetic Measurements [Calculation].—Krishnan & Bose. (*Nature*, 19th Feb. 1938, Vol. 141, p. 329.)

2568. Stimulation of Paramagnetic Absorption by a Constant Field [at Frequency 3.7×10^6].—Brons & Gorter. (*Nature*, 26th Feb. 1938, Vol. 141, p. 369.)

2569. The Electrical Resistance of Ferromagnetics [Behaviour above and below Curie Point].—Potter. (*Proc. Phys. Soc.*, 1st Nov. 1937, Vol. 49, Part 6, No. 276, pp. 671–678.)

2570. Magnetic Interaction in Homogeneously Strained Ferromagnetic Crystals [Inadequacy of purely Magnetic Interaction to account for Magnetostriction].—McKeehan. (*Phys. Review*, 15th Feb. 1938, Vol. 53, No. 4, pp. 301–307.)

2571. The Variation of the Elasticity Modulus of Ferromagnetic Materials with Temperature and Magnetic Field.—Engler. (*Ann. der Physik*, Series 5, No. 2, Vol. 31, 1938, pp. 145–163.)

2572. Magnetic Anisotropy in Sheet Steel.—Ingerson & Beck. (*Review Scient. Instr.*, Jan. 1938, Vol. 9, No. 1, pp. 31–35.)

2573. On the Theory of Absorption and Dispersion in Paramagnetic Crystals under Alternating Magnetic Fields.—Kronig. (*Physica*, Feb. 1938, Vol. 5, No. 2, pp. 65–80: in English.)

2574. Magneto-Damping in Nickel [Experiments showing how Internal Damping is affected by Various Physical Conditions].—Waller. (*Proc. Phys. Soc.*, 1st Jan. 1938, Vol. 50, Part 1, No. 277, pp. 144–146: demonstration.)

2575. The Growth of the Nuclei of Magnetisation Change for Large Barkhausen Discontinuities [Theory including Consideration of Surface Energy of Boundary between Oppositely-Magnetised Regions; Evaluation of Experimental Results gives Magnitude of Boundary Energy].—Döring. (*Zeitschr. f. Physik*, No. 3/4, Vol. 108, 1938, pp. 137-152.)

2576. Demagnetisation Coefficient of Oblate Spheroids [Empirical Equation].—Tarasov. (*Phys. Review*, 1st Jan. 1938, Series 2, Vol. 53, No. 1, p. 105.)

2577. Magnetic Properties of Tellurium on Colloidalisation [Size of Particle has no Bearing on Change in Susceptibility, which is due to Impurities].—Prasad & Dharmatti. (*Indian Journ. of Phys.*, Jan. 1938, Vol. 11, Part 6, pp. 393–398.)

2578. Dia- and Paramagnetism in Series of Metallic Mixed Crystals: V—Behaviour of Cobalt and Rhodium in Solution.—Hildebrand. (*Ann. der Physik*, Series 5, No. 7, Vol. 30, 1937, pp. 593–608.)

2579. Magnetic Testing.—Sanford. (*U.S. Dept. of Commerce: Nat. Bur. of Stds. Circular* C 17: 8th Nov. 1937: 34 pp.)

2580. "Introduction to Ferromagnetism."—Bitter. (At Patent Office Library, London: Cat. No. 78 279: 326 pp.)

2581. Influence of Magnetic Field on the Potential Gradient in Plasma.—Reichrudel & Spivak. (*Comptes Rendus* (*Doklady*) *de l'Ac. des Sci. de l'URSS*, No. 3, Vol. 18, 1938, pp. 177–179: in English.)

2582. On the Theory of Probes in Gases at High Pressures [Relation between Probe Voltage, Probe Current, and Thickness of Surrounding Gas Sheath, taking account of Collisions within the Sheath].—Borgnis. (*Ann. der Physik*, March 1938, Vol. 31, No. 6, pp. 497–504.)

2583. The Absorption ["Clean-Up"] of the Inert Gases in the Electric [Glow] Discharge: Parts II & III.—Alterthum & Lompe. (*Zeitschr. f. tech. Phys.*, No. 4, Vol. 19, 1938, pp. 113–116 & 116–118.)

In Part I (1132 of 1937) it was shown that the phenomenon is due to the penetration of the gas atoms into the cathode. The present work investigates the influence of the shape and crystal structure of the electrodes, the cathode drop, and other factors, on the rate of dissipation as measured by the rate of fall of pressure. None of these factors is found to be answerable for the large differences between the rates given by the various materials.

2584. On the Resistance of a Vacuum Spark.—Sanner. (*Zeitschr. f. Physik*, Feb. 1938, Vol. 108, No. 5/6, pp. 288–294.)

Resistance of a spark discharge in vacuum is practically zero at instant of discharge and gradually rises. With electrodes of Al & Cu, resistance was 0.01 ohm after 50 μsec; with carbon electrodes 0.03 ohm. Total time of discharge 100 to 125 μsec.

2585. On the Current-Controlled Discharge.—Schade. (*See* 2219.)

2586. Probability of Collisions of the Second Kind between Atoms and Free Electrons [as in Gaseous Discharge: Use of Klein-Rosseland Relation].—Fabrikant. (*Comptes Rendus* (*Doklady*) *de l'Ac. des Sci. de l'URSS*, No. 5, Vol. 17, 1937, pp. 249–250: in English.)

2587. The Effect of Metastable Atoms on the Current Strength of the Unspontaneous Discharge in Neon, *and* On the Measurement of the Ionisation Coefficients in Pure Neon and in Neon-Argon Mixtures.—Glotow. (*Physik. Zeitschr. der Sowjetunion*, No. 3, Vol. 12, 1937, pp. 235–255: pp. 256–268: in German.)

2588. The Longitudinal Field Strength of the Positive Column in the Low-Pressure Discharge of Gas Mixtures for Various Current Strengths and Pressures [Probe Measurements in Neon-Argon Mixtures].—Alterthum & Lompe. (*Ann. der Physik*, Series 5, No. 1, Vol. 31, 1938, pp. 1–28.)

2589. Pre-Striking Currents in a Thyratron [Derivation of Expression for Current, and Experimental Checking: Application to explain Mechanism of Striking].—Wheatcroft, Smith, & Metcalfe. (*Phil. Mag.*, April 1938, Vol. 25, No. 169, pp. 649–663.)

2590. Physical Principles of Gas-Filled Hot-Cathode Rectifiers.—Druyvesteyn & Mulder. (*Philips Transmitting News*, Nov. 1937, Vol. 4, No. 5, pp. 14–28: in German & English concurrently.)

2591. Contribution to the Problem of the Use of Glow-Discharge Lamps for Stroboscopic Demonstrations and Measurements.—Landolt. (*Bull. Assoc. suisse des Élec.*, No. 23, Vol. 28, 1937, pp. 598–599: in German.) *See* also *ibid.*, No. 2, Vol. 29, 1938, p. 42.

2592. Stationary and Variable Temperature Distributions along Wires and Bars heated by Conduction Currents or by Radiation.—Fischer. (*Zeitschr. f. tech. Phys.*, No. 4, Vol. 19, 1938, pp. 105–113.) Conclusion of the paper referred to in 1896 of May.

2593. "Elektrische Kontakte" [for Small Currents: Book Review].—Burstyn. (*Rev. Gén. de l'Élec.*, 16th April 1938, Vol. 43, No. 16, p. 482.)

2594. Latest Sucking-Coil Relays ["Tauchspulrelais": Movement resembling That of M.C. Loudspeakers: High Sensitivity, Very Low Inductance and Capacity].—Bräuer. (*E.T.Z.*, 3rd March 1938, Vol. 59, No. 9, pp. 225–227.)

2595. Explosion Relays and Their Applications.—Andrianov & Demidov. (*See* 2629.)

2596. A Coincidence Amplifier of High Resolving Power.—Herzog & Weber. (*Helvet. Phys. Acta*, Fasc. 5, Vol. 10, 1937, pp. 422–424: in German.)

2597. Direct-Current Amplifiers: a Review.—Aerovox Corporation. (*See* 2248.)

2598. A Scale-of-Eight Counting Unit [using Gas-Filled Triodes].—Giarratana. (*Review Scient. Instr.*, Oct. 1937, Vol. 8, No. 10, pp. 390–393.) For another scale-of-eight circuit *see* 2100 of May.

2599. Screening Effect of Cans made of Metallised Paper [compared with Sheet Aluminium Can, Paper metallised with Aluminium only 3–10% Effective, or with Zinc 11–50%].—(*See* paper dealt with in 2622, below.)

2600. Base Metal Thermocouples: Their Characteristics [Particularly Nichrome-Constantan Couples].—Mandlekar & Banerjea. (*Current Science*, Bangalore, March 1938, Vol. 6, No. 9, pp. 447–448.)

2601. Radiation Thermopiles [Technique of Solder-less Construction, etc.].—Pfund. (*Review Scient. Instr.*, Nov. 1937, Vol. 8, No. 11, pp. 417–419.)

2602. Soft Solder Fluxes.—Barber. (*Journ. Scient. Instr.*, Dec. 1937, Vol. 14, No. 12, p. 424: summary only.) *See* also 2857 of 1936.

2603. Ultra-Centrifuges [and "Ultra"-Turbines: Speeds of (*e.g.*) 20 000 r.p.s: of Possible Use for Various Research Purposes: Short Survey].—Keil. (*Zeitschr. V.D.I.*, 29th Jan. 1938, Vol. 82, No. 5, pp. 115–117.)

2604. A New Micrometer Ratchet [using Helical Spring as Ratchet: Increased Accuracy].—Werring. (*Bell Lab. Record*, Jan. 1938, Vol. 16, No. 5, pp. 162–163.)

STATIONS, DESIGN AND OPERATION

2605. High-Fidelity Broadcasting at Ultra-High Frequencies [Need for Facilities for Increased Volume Range when allotting Frequency Channels—Monitor Tone for Automatic Expansion is Impossible on Medium-Wave Broadcast Channel: Alternative Use of Frequency Modulation may require Increased Band Width: etc.].—Herold. (*Proc. Inst. Rad. Eng.*, March 1938, Vol. 26, No. 3, pp. 383–384.)

2606. The Belfast/Stranraer 9-Circuit Ultra-Short-Wave Radio-Telephone System.—Mirk. (*P.O. Elec. Eng. Journ.*, April 1938, Vol. 31, Part 1, pp. 33–40.) *See* also 1234 of March.

2607. A Picturesque Use of [Ultra-] Short Waves [for Communication between Car and Cabins in Telpher Railway].—(*L'Onde Élec.*, March 1938, Vol. 17, No. 195, p. 151.)

2608. The France/United States Radio-Telephonic Service.—Villem & Aubert. (*Bull. de la S.F.R.*, 4th Quarter 1937, Vol. 11, No. 5, pp. 130–150.)

2609. The Experimental Short-Wave Broadcasting Station PCJ.—Nordlohne. (*Philips Tech. Review*, Jan. 1938, Vol. 3, No. 1, pp. 17–27.) For its rotating beam aerial see *ibid.*, Feb. 1938, No. 2, pp. 59–64: *also* 1415 of April.

2610. De Luxe Battery Operated [Short-Wave] Portable Stations: Field Sets used by the National Park Service.—Waterhouse & Hilgedick. (*QST*, April 1938, Vol. 22, pp. 20–22 and 68, 70.) Output 3 watts, giving 100 miles consistent telephony.

2611. The 'Varsity Boat Race: Equipment for the Radio Link.—(*World-Radio*, 1st April 1938, Vol. 26, pp. 10–11.)

2612. New Radio-Telegraphic System using Seven Frequencies [simultaneously, Corresponding to 7 Elements of Letter (divided by 7 Horizontal Lines): for Elimination of Selective Fading, etc.].—Devaux. (*Génie Civil*, 26th March 1938, Vol. 112, No. 13, p. 280: *Rev. Gén. de l'Élec.*, 5th March 1938, Vol. 43, No. 10, p. 290.) Already employed for a month on the Paris/Algiers service.

2613. Studio Equipment for League of Nations, Geneva.—(*Philips Transmitting News*, Nov. 1937, Vol. 4, No. 5, pp. 10–13: in German & English concurrently.)

2614. Compromises in Allocation Engineering.—Wilmotte. (*Communications*, March 1938, Vol. 18, No. 3, pp. 23 and 40, 41.)

2615. Noise Protection for Voice-Operated Devices [Echo-Suppressors and Vodas].—Wright. (*Bell Lab. Record*, March 1938, Vol. 16, No. 7, pp. 248–253.)

GENERAL PHYSICAL ARTICLES

2616. The Energy Balance for an Infinitely Small Electron Current in a Uniform Electric Field [Calculation (for Various Gases) of Percentage of Energy expended in Elastic Losses, Ionisation, Electron Acceleration, etc.].—Penning. (*Physica*, April 1938, Vol. 5, No. 4, pp. 286–297: in English.)

2617. The X Particle [carrying the Energy in Cosmic Radiation: Suggested Identity with Dirac's Particle with Same Charge as Electron but Spin greater than $\frac{1}{2}$: Properties of Such a Particle], *and* New Atomic Particles forecast in Cosmic Radiation.—Bramley: Langer. (*Science*, 25th March 1938, Vol. 87, pp. 281–282: *Sci. News Letter*, 2nd April 1938, Vol. 33, pp. 218–219.)

2618. Magnetism and the Vibratory Electron.—Taylor Jones. (*Phil. Mag.*, April 1938, Vol. 25, No. 169, pp. 682-693.)

Further development of the work referred to in 2028 of 1936 and 413 & 4375 of 1937. In the vibrational theory "an electromagnetic field contains only one kind of energy, and it is unnecessary to regard space as filled with three kinds, electrical, magnetic, and vibrational, the first two kinds being merely changes in the amount of the third."

2619. On the Scattering & Dissociation of Slow Ions [and the Effective Cross-Section for Five Types of Collision].—Wolf. (*Ann. der Physik*, March 1938, Vol. 31, No. 6, pp. 561–568.)

2620. Some Remarks on the Principle of the Conservation of Electricity.—Boutaric. (*Journ. de Phys. et le Radium*, Feb. 1938, Vol. 9, No. 2, pp. 67–68.)

MISCELLANEOUS

2621. "Differential Systems" [Theory of Pfaffian Systems treated from Algebraic Standpoint: Book Review].—Thomas. (*Phil. Mag.*, April 1938, Vol. 25, No. 169, p. 704.)

2622. Report on the Activity of the Physikalisch-Technische Reichsanstalt for the Year 1937.—(*Physik. Zeitschr.*, 15th March 1938, Vol. 39, No. 6, pp. 233–286.)

Radio subjects mentioned include:—Use of luminous quartz resonators as standards of frequency, damping measurements on 60 kc/s quartz oscillators (p. 257), frequency multiplying with a detector, current and voltage measurements at high frequencies (p. 258), screening by metallised paper, cage damping at high frequencies, special valves, ultra-short waves (p. 259).

2623. "Forschung und Prüfung: 50 Jahre Physikalisch-Technische Reichsanstalt" [Book Review].—Stark (Edited by). (*Akust. Zeitschr.*, March 1938, Vol. 3, No. 2, p. 99.)

2624. Work-Bench Illumination [for Fine Assembly Work].—Halbertsma. (*Philips Tech. Journ.*, Feb. 1938, Vol. 3, No. 2, pp. 53–57.)

2625. Suppression of Mechanical Relays in the Control of Printing Chronographs [Objections to Thyratrons and Glow-Discharge Relays: Use of 20-Watt Triode].—Lallemand. (*Journ. de Phys. et le Radium*, March 1938, Vol. 9, No. 3, Supp. pp. 49–50 S.) Functioning with "remarkable regularity and safety."

2626. Inertia-less Selection in Telemechanics [Use of Multiple-Contact Electron-Ray Tubes is "Irrational": Multi-Element Selector using Thyratrons].—Kelson. (*Automatics & Telemechanics* [in Russian], No. 1, 1937, pp. 3–21.)

2627. Effect of Variation of Line Parameters on the Errors of Telemetric Installations, and the Increasing of Their Efficiencies.—Zhdanov. (*Automatics & Telemechanics* [in Russian], No. 3, 1937, pp. 41–67.)

2628. The Amplification in a Valve with Regulating Parameters (*R*, *L*, *C* forming Potentiometer or Phase Regulator) in Grid Circuit.—Vartelsky. (*See* 2249.)

2629. Explosion Relays and Their Application in Schemes of Automatic Control [Relays based on Ignition, by Electric Spark, of Oxyhydrogen Gas].—Andrianov & Demidov. (*Automatics & Telemechanics* [in Russian], No. 4, 1937, pp. 57–66.)

2630. On the Automatic Control of Exact Dimensions in Machine Construction and Metal Working.—Burlov. (*Automatics & Telemechanics* [in Russian], No. 4, 1937, pp. 101–112.)

2631. Introduction of Automatics in the Industry of Ferrous Materials [including Telemetering and Control of Strip Tension and Thickness, Cold-Rolling Pressure, etc.].—Telishevsky. (*Automatics & Telemechanics* [in Russian], No. 5, 1937, pp. 69–86.)

2632. An Electronic [Welding-] Arc-Length Monitor.—Richter. (*Elec. Engineering*, March 1938, Vol. 57, No. 3, Supp. pp. 115–117: Discussion, April 1938, No. 4, Supp. p. 226.)

2633. "Einführung in die Lehre vom Schuss" [Projectiles: including Modern Methods of Ballistic Measuring Technique: Book Review].—Gey & Teichmann. (*Zeitschr. f. tech. Phys.*, No. 3, Vol. 19, 1938, p. 87.)

2634. Vibrations of a Rifle Barrel [Investigation of "Flip" by C-R Oscillograph and Gramophone Pickup].—Martin & Muir. (*Journ. Roy. Tech. Coll.*, Glasgow, Jan. 1938, Vol. 4, Part 2, pp. 213–238.)

2635. Electrical Gauges, *and* The Use of Electrical Gauges for Measurement [of Finished Parts] and Control [of Machine Tools].—Froböse: Hermann & Schmid. (*E.T.Z.*, 31st March 1938, Vol. 59, No. 13, pp. 343–344: p. 344: summaries only.)

2636. Recent Trends in Electronic Technology [including Movable-Anode Valve for Micrometry: Car "Speeding" Warner: etc.].—Fink. (*Elec. Engineering*, March 1938, Vol. 57, No. 3, pp. 100–107.)

2637. The Rapid Measurement of Moisture Content: an Industrial Use of Changes in Dielectric Properties.—Thomas & Irvine. (*Journ. of Council for Sci. & Ind. Res.*, Australia, Feb. 1938, Vol. 11, No. 1, pp. 73–76.) Designed primarily for the testing of cheese, but with many other applications. Resonance is indicated by a "magic eye" 6E5 tuning indicator.

2638. Dew-Point Potentiometer for Determining the Moisture Content of Gases [in Industrial Furnaces].—Stack. (*Gen. Elec. Review*, Feb. 1938, Vol. 41, No. 2, pp. 106–108.)

2639. The Utilisation of Radioactive Phenomena in the Pre-Detection of Fires and the Analysis of Gases.—Breitmann & Malsallez. (*Rev. Gén. de l'Élec.*, 26th Feb. 1938, Vol. 43, No. 9, pp. 279–284.)

2640. Detecting the Presence of Insects in Growing Crops [in Hawaii: Crystal Microphone, High-Gain Amplifier, and Crystal Headphone Receivers].—(*Rad. Review of Australia*, Nov. 1937, Vol. 5, No. 11, p. 303.)

2641. Determination of the Wavelengths of the Radiation emitted by Electrical Insulators [on Electrification by Friction]: Attempted Theoretical Interpretation.—Perrier. (*Comptes Rendus*, 14th March 1938, Vol. 206, No. 11, pp. 831–833.)

2642. A Large Absolute Dosimeter for X-Rays working with a Directly Coupled Electrometer Triode [Sensitivity up to 10^{-9} Röntgen/Second].—Drigo. (*La Ricerca Scient.*, 15th/28th Feb. 1938, Series 2, 9th Year, Vol. 1, No. 3/4, pp. 107–115.)

2643. High-Frequency Currents and Their Applications to Industrial Operations, patricularly to the Treatment of Rubber.—Leduc. (*Rev. Gén. de l'Élec.*, 2nd April 1938, Vol. 43, No. 14, pp. 441–447.)

2644. Some Applications of High-Frequency [10–20 Mc/s] Electric Currents to the [Rubber] Latex Industry.—Leduc. (*Recherches et Inventions*, April 1938, No. 275, pp. 78–81.) For vulcanisation *see* 1661 of 1936.

2645. The Electrical Phenomena of the Brain during Mental Activity.—Rohracher. (*Elektrot. u. Masch:bau*, No. 8, Vol. 56, 1938, p. 103: summary only.)

2646. Italian Action on the Improvement of Wheat, etc., by Irradiation with Ultra-Short Waves.—(*Rad., B., F. für Alle*, Jan. 1938, No. 191, p. 14.)

2647. The Action of Electricity on the Organism [Survey of Research on Electric Shock].—Krüger. (*Zeitschr. V.D.I.*, 19th March 1938, Vol. 82, No. 12, pp. 344–346.)

2648. On a New Kind of Electret: Photoelectrets [Dielectrics given Permanent Polarisation under the Combined Influence of Light & an Electric Field].—Nadjakoff. (*Physik. Zeitschr.*, 15th March 1938, Vol. 39, No. 6, pp. 226–227.)

2649. Liquid-Level Control Apparatus [based on Differences in Electrical Conductivity].—Hersh & others. (*Indust. & Eng. Chemistry*, March 1938, Vol. 30, No. 3, pp. 363–364.)

2650. Photoelectric Relay Unit [for Heights of Liquid: making Use of Fact that a Meniscus, even of a Transparent Liquid, will Cut Off a Light Ray].—Josten. (*Indust. & Eng. Chemistry*, Analytical Edition, 15th March 1938, Vol. 10, No. 3, p. 165.) Used in a new device, the "Distillograph," to record distillation data.

2651. Description of Two Relays incorporating Photocells.—Grace. (*Journ. Scient. Instr.*, April 1938, Vol. 15, No. 4, pp. 128–132.)

2652. Photoelectric Registration of Star Transits [for Clock Corrections].—Pavlov. (*Bull. de l'Ac. des Sci. de l'URSS*, Série Physique, No. 4/5, 1937, pp. 633–666: English summary pp. 666–672.)

The faintest star recorded satisfactorily was of 4.9 magnitude, giving a photocurrent of less than 6×10^{-15} A and requiring (to work the undulator employed) an amplification of at least 3×10^{11}.

2653. Phototube Colour Analyser used in Chemical Research [Automatic Spectrophotometer used for Detection of Chemical Elements].—Hardy. (*Electronics*, March 1938, Vol. 11, pp. 40 and 42.)

2654. The Automatic Photo-Electronic Analyser [for Turbidity, Residual Chlorine, etc., of Water, and Other Uses].—Mikhailov. (*Automatics & Telemechanics* [in Russian], No. 3, 1937, pp. 7–40.)

2655. Photocell Automatics in Machine Construction [Lathe, etc., controlled by Photocell reading direct from Drawing], *and* Electro-Automatic Copying [on Milling Machine, from Template] after Leonard's System.—Vikhmann: Sokolov. (*Automatics & Telemechanics* [in Russian], No. 1, 1937, pp. 33–49: No. 3, 1937, pp. 141–156.)

2656. The Precision Measurement of Incandescent Lamps with Selenium Barrier-Layer Photocells.—König. (*Bull. Assoc. suisse des Élec.*, No. 17, Vol. 28, 1937, pp. 385–393.)

2657. Selenium Photoelements and Their Employment [for Various Applications].—Behrendt. (*See* 2475.)

2658. Phototube Drawer-Opener used to Safeguard Dental Patients [preventing Transference of Disease by touching Dental-Cabinet Drawers].—(*Electronics*, March 1938, Vol. 11, No. 3, p. 40.)

2659. A Recording Photoelectric Spectroradiometer.—Albers & Knorr. (*Journ. Opt. Soc. Am.*, April 1938, Vol. 28, No. 4, pp. 121–123.)

Some Recent Patents

The following abstracts are prepared, with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

ACOUSTICS AND AUDIO-FREQUENCY CIRCUITS AND APPARATUS

479 003.—Push-pull circuit for amplifying currents derived from "unbalanced" or "grounded" sources such as a microphone, or a cathode-ray tube.

Standard Telephones and Cables (assignees of N. C. Norman). Convention date (U.S.A.) 26th September, 1936.

479 485.—Low-frequency amplifier with a non-linear feed-back connection designed to produce volume contraction or expansion.

G. W. Johnson (communicated by Philco Radio and Television Corpn.) (divided out of 479 440*). Application date 4th August,* 1936.

479 549.—Multiple-unit loud-speaker installation for public-address system.

Telefunken Co. Convention date (Germany) 16th December, 1935.

AERIALS AND AERIAL SYSTEMS

479 118.—Screened aerial coupling and transmission line, particularly for all-wave receivers.

F. R. W. Strafford and O. S. Higher. Application date 29th May, 1936.

481 242.—Construction and disposition of the wireless aerial on a motor car.

K. T. Hardman. Application date 8th June, 1937.

481 806.—Aerial coupling in which a "dummy" lead is used to neutralise inductive "pick-up" or static interference.

E. K. Cole and G. Bradfield. Application date 18th September, 1936.

DIRECTIONAL WIRELESS

479 689.—Direction-finder provided with a method of automatic volume control which does not vary with the direction of the incoming signals.

The Plessey Co. and C. E. G. Bailey. Application date 8th August, 1936.

479 747.—Radio navigational system depending upon the directive response of two independent receiving sets of balanced sensitivity.

J. R. Steinhoff. Convention date (U.S.A.) 14th May, 1935.

479 936.—Method of applying automatic volume control to amplifiers associated with a direction-finding system so as to maintain the gain-ratio constant over a given range.

The Plessey Co. and C. E. G. Bailey (addition to 479 689*). Application date 8th August,* 1936.

RECEIVING CIRCUITS AND APPARATUS

(*See also under Television*)

478 754.—All-wave receiving set in which constant reaction is obtained, if desired, on all settings of the wave-band switch.

E. K. Cole and H. A. Brooke. Application date 3rd October, 1936.

478 791.—Short-wave amplifier in which in order to prevent undesired reaction the tuned circuits connecting the cathode, grid, and anode have no parts in common except those electrodes.

Standard Telephones and Cables (assignees of A. L. Samuel). Convention date (U.S.A.) 8th May, 1936.

478 800.—Radio receiver comprising only two amplifiers and two tuned circuits, these being arranged to provide effective automatic volume control.

N. V. Philips' Lamp Co. Convention date (Germany) 6th July, 1936.

478 826.—All-wave superhet set with means for preventing self-oscillation on any of the different wave-bands.

Hazeltine Corpn. (assignees of N. P. Case). Convention date (U.S.A.) 28th September, 1935.

479 599.—Wireless receiver with automatic selectivity control based upon the use of negative feedback.

A. D. Blumlein and W. H. Connell. Application date 8th July, 1936.

479 768.—Method of coupling a local oscillator valve to a pentagrid converter valve for frequency-changing in a superhet set.

Marconi's W.T. Co. (assignees of E. W. Herold). Convention date (U.S.A.) 10th August, 1935.

479 938.—Arrangement of slow-motion tuning device for a wireless set with means for speeding-up the movement when desired.

E. Czobor and M. Czobor. Convention date (France) 22nd August, 1935.

480 441.—All-wave tuning indicator for a wireless set in which each scale is adapted to be viewed by itself, and has a contour giving maximum band-spread and visibility.

Marconi's W.T. Co. Convention date (U.S.A.) 19th August, 1935.

479 788.—Means for suppressing the so-called "image signals" in a superhet set.

Philco Radio and Television Corpn. Convention date (U.S.A.) 27th April, 1936.

480 533.—Cord-and-pulley driving-gear for the tuning indicator of a wireless set.

Standard Telephones and Cables (communicated by L. van Bulck). Application date 22nd August, 1936.

480 724.—"Non-microphonic" or shock-proof method of mounting the high-frequency tuning components of wireless apparatus.

Marconi's W.T. Co. Convention date (U.S.A.) 31st August, 1935.

481 062.—Tuning arrangement in which means are provided for preventing fluctuations in the supply voltage from affecting the value of the biasing voltage used to control the frequency say of the local oscillator of a superhet set.

L. L. de Kramolin. Convention dates (Germany) 8th November, 1935 and 28th March, 1936.

481 221.—Motor-car superhet set with means for cutting-out "image" frequencies, as well as disturbances due to the ignition system.

G. W. Johnson (communicated by Philco Radio and Television Corpn.). Application date 15th December, 1936.

481 330.—Stabilising the operation of the local-oscillator valve on each setting of the wave-band switch in an all-wave superhet set.

The British Thomson-Houston Co. Convention date (U.S.A.) 11th March, 1936.

481 731.—Wireless receiver in which the presence of interfering signals or artificial "static" automatically regulates the selectivity of the tuned circuits.

Electric and Musical Industries (assignees of E. N. Muller). Convention dates (Luxembourg) 15th June, 1935 and 5th May, 1936.

TELEVISION CIRCUITS AND APPARATUS

For Transmission and Reception

478 599.—Means for applying a steady flux or "picture shift" field to scanning oscillators of the magnetic type as used with cathode-ray tubes.

Ferranti ; M. K. Taylor ; and J. C. Wilson. Application date 28th July, 1936.

478 641.—Electron discharge tube in which the image signal on a photo-sensitive screen is intensified by the action of photo-sensitive and fluorescent electrodes interposed between a photo-emissive cathode and the final fluorescent screen.

V. Zeitline ; A. Zeitline ; and V. Kliatchko. Convention date (France) 18th May, 1935.

478 653.—Method of controlling the electron stream in cathode-ray tubes used for television.

V. Zeitline ; A. Zeitline ; and V. Kliatchko. Application date 21st January, 1936.

478 666.—Magnetic focusing coil for a cathode-ray tube, designed to produce a uniform distribution of the controlling flux.

Fernseh Akt. Convention date (Germany) 23rd July, 1935.

478 815.—Amplifier stage for a cathode-ray television receiver in which different output impedances are provided for separating the modulating and synchronising signals.

The General Electric Co. ; D. C. Espley ; and G. W. Edwards. Application dates 24th July, 1936, and 25th May, 1937.

478 831.—Combined television and broadcast receiver provided with two sets of electrically-separate tuned circuits and a single tuning control for operating both.

The General Electric Co. and N. R. Bligh. Application date 18th September, 1936.

478 852.—Electron-image reproducer in which means are provided to prevent any rotation of the "secondary" image relatively to the primary picture.

N. V. Philips' Lamp Co. Convention date (Germany) 30th December, 1935.

478 939.—Means for preventing the type of disturbance in a television transmitter which produces spurious patches of brightness in the receiver.

Telefunken Co. Convention date (Germany) 9th June, 1936.

478 967.—Combined cathode-ray television transmitter and amplifier, with means for reducing "noise" and increasing the efficiency with which the higher frequencies are handled.

Marconi's W.T. Co. Convention date (U.S.A.) 26th July, 1935.

479 064.—Cathode-ray tube in which the deflecting plates are all located at the same distance from the screen, and are concave in cross-section towards the axis of the tube.

The British Thomson-Houston Co. and D. Gabor. Application date 31st July, 1936.

479 113.—Time-base circuit for television in which negative feed-back is used to correct the saw-toothed wave output.

A. D. Blumlein. Application date 29th April, 1936.

479 139.—Time-base circuit with switching means adapted to give single-line or interlaced scanning at will.

Radio-Akt D. S. Loewe. Convention date (Germany) 22nd August, 1935.

479 149.—Means for regulating the size of the picture and for centering it on the fluorescent screen of a cathode-ray television receiver.

E. Michaelis. Application date 23rd September, 1936.

479 275.—Relaxation oscillation-generator for producing saw-toothed wave-forms suitable for use in television scanning.

C. L. Faudell and E. L. C. Waite. Application dates 1st and 19th May, 1936.

479 305.—Means for correcting the "trapezium" distortion which occurs in a television transmitter of the Iconoscope type.

Radio-Akt D. S. Loewe. Convention date (Germany) 19th August, 1935.

479 318.—Luminescent screen for use in a cathode-ray tube where the picture is reproduced by incandescence, as distinct from fluorescence.

Farnsworth Television Inc. Convention date (U.S.A.) 9th March, 1936.

479 356.—Cathode-ray tube in which the fluorescent screen is so mounted and "masked" as to show the received picture with sharply-defined edges.

J. W. Strange and W. H. Connell. Application date 1st August, 1936.

479 413.—Film television transmitter fitted with optical compensation and with a picture scanner having a "storage" effect.

Telefunken Co. Convention date (Germany) 8th June, 1936.

479 420.—Means for regulating the effect of an electron-optical focusing system, using magnetic lenses, in a cathode-ray tube.

The British Thomson-Houston Co. Convention date (Germany) 5th August, 1936.

479 458.—Correcting for the distortion produced when a fixed object or landscape is scanned at low speed from a moving vehicle, such as an aeroplane.

Baird Television ; T. M. C. Lance ; and B. B. Austin. Application date 6th August, 1936.

479 471.—Means for producing an increased deflectional sensitivity of the electron stream passing through a cathode-ray tube.

Fernseh Akt. Convention date (*Germany*) *7th August,* 1935.

479 500.—Method of producing the synchronising impulses in an interlaced scanning system of the rotating-disc type.

Radio-Akt D. S. Loewe. Convention date (*Germany*) *6th August,* 1935.

479 551.—Means for co-ordinating the illumination and subsequent scanning of the photo-sensitive screen of a cathode-ray television transmitter.

Radio-Akt D. S. Loewe. Convention date (*Germany*) *10th December,* 1935.

479 617.—Light amplifying cell for increasing the size or brightness of received television pictures.

F. Skaupy. Convention date (*Germany*) *24th September,* 1935.

479 732.—Variable-frequency relaxation oscillation-generator for use as a timing circuit for a cathode-ray tube.

Radio-Akt D. S. Loewe. Convention date (*Germany*) *20th June,* 1936.

479 737.—Eliminating leakage fields, likely to cause distortion of the picture, in a television receiver energised from electric supply mains.

C. Lorenz Akt. Convention date (*Germany*) *7th July,* 1936.

479 750.—Means for producing a desired potential gradient along the path of the electron stream through a cathode-ray tube, for use in television.

Baird Television and P. W. Willans. Application date 10th July, 1936.

479 751.—Preventing the field from the magnetic movement of a loud speaker from distorting the picture in a combined television and sound receiver.

J. E. Mead and H. G. M. Spratt. Application date 5th August, 1936.

479 760.—Preventing distortion of the saw-toothed scanning currents applied to the external deflecting coils of a cathode-ray tube used for television.

Baird Television and D. M. Johnstone. Application date 10th August, 1936.

479 761.—Cathode-ray tube for television provided with means for accentuating the picture signals by secondary emission.

Baird Television and C. Szegho. Application date 10th August 1936.

479 935.—Method of deriving from a high-frequency oscillation a lower frequency having a predetermined phase-relation with the first, particularly for television scanning.

Baird Television ; D. M. Johnstone ; and V. Jones. Application dates 13th July and 8th October, 1936.

480 483.—Neutralising in a television transmitter the effect of casual fluctuations in the intensity of the light source used to illuminate the scene.

Standard Telephones and Cables (*assignees of A. W. Horton, Junr.*). *Convention date* (*U.S.A.*) *23rd July,* 1936.

480 532.—Arrangement and spacing of the apertures used to produce the synchronising impulses in a film television scanner of the rotating-disc type.

The British Thomson-Houston Co. and S. R. Eade. Application date 22nd August, 1936.

TRANSMITTING CIRCUITS AND APPARATUS

(*See also under Television*)

478 708.—Modulation system in which the carrier-wave is varied as regards both phase and duration, or, as it is called, "pulse width."

Marconi's W.T. Co. and W. T. Ditcham.

479 808.—Negative feed-back circuit, including a bridge network, for reducing distortion in amplifiers and modulators.

Standard Telephones and Cables (*assignees of E. Peterson*). *Convention date* (*U.S.A.*) *1st April,* 1936.

478 994.—Modulating system of the balanced Wheatstone-bridge type with means for suppressing the unmodulated part of the carrier wave.

Standard Telephones and Cables (*assignees of R. R. Riesz*). *Convention date* (*U.S.A.*) *7th July,* 1936.

479 302.—Stabilised modulating systems of the "valve bridge" type. *Telefunken Co. Convention dates* (*Germany*) *12th August, 21st, 29th and 30th November, and 3rd December,* 1935.

479 388.—Negative feed-back arrangement for giving an amplifier any desired "distortion" characteristic for condensing or expanding the volume range of signals.

C. E. P. Jones. Application dates 5th August, 1936 *and 15th January,* 1937.

479 658.—Multiplex high-frequency signalling system with means for suppressing the carrier-wave energy in each channel during non-signalling periods.

Standard Telephones and Cables (*assignees of Le Matériel Téléphonique Soc. Anon.*). *Convention date* (*France*) *18th July,* 1936.

479 731.—Method of increasing the effective modulation in facsimile telegraph and television transmitters.

Marconi's W.T. Co. (*assignees of C. W. Hansell*). *Convention date* (*U.S.A.*) *5th June,* 1936.

479 993.—Apparatus for measuring the percentage modulation of the aerial current in a short-wave transmitter.

Siemens and Halske Akt. Convention date (*Germany*) *11th July,* 1936.

480 289.—Transmitting wireless Morse signals so that different frequencies are used for spacing and marking in order to reduce fading and interference.

Cable and Wireless ; A. M. Humby ; J. A. Smale ; and E. G. Copper. Application date 9th March, 1937.

480 548.—Short-wave transmitting system in which the carrier-wave, after modulation, is stepped-up in frequency during which process the percentage of modulation is increased.

Standard Telephones and Cables (*assignees of Le Matériel Téléphonique Soc. Anon.*). *Convention date* (*France*) *6th March,* 1936.

480 847.—Suppressed-carrier single-side-band transmission system in which synchronising signals for controlling the receiver are included in the radiated wave.

Telefunken Co. Convention date (*Germany*) *20th July,* 1936.

481 255.—Magnetic amplifiers or modulators, particularly for handling telegraphic signals.

Standard Telephones and Cables (*assignees of E. M. Boardman*). *Convention date* (*U.S.A.*) *20th August,* 1936.

CONSTRUCTION OF ELECTRONIC-DISCHARGE DEVICES

478 613.—Electrode arrangement for an electron multiplier of the type in which the stream moves in crossed electric and magnetic fields.

The General Electric Co. and W. H. Aldous. Application date 10th November, 1936.

478 812.—Electron discharge tubes of the kind in which spaced electrodes are used in combination with focusing or directing "rods" to produce directed jets or beams of electrons.

J. H. O. Harries. Application date 25th May, 1936.

478 926.—Method of manufacturing and exhausting electron discharge devices, such as cathode-ray tubes.

N. V. Philips' Lamp Co. Convention date (Germany) 23rd April, 1936.

478 970.—Electron multipliers of the secondary emission type with means for modulating the output current in accordance with signals applied to a magnetic control field.

Marconi's W.T. Co. Convention date (U.S.A.) 26th July, 1935.

479 190.—Method of preparing secondary-emission electrodes used in electron discharge tubes.

N. V. Philips' Lamp Co. Convention date (Germany) 12th October, 1936.

479 226.—Means for varying the active point of emission on the cathode of an electron-discharge tube in order to prevent "pitting" or the formation of craters on its surface.

Cie pour la Fabrication des Compteurs et Matériels d'Usines à Gaz. Convention date (France) 15th November, 1935.

479 270.—Means for rotating the cathode of a cathode-ray tube so as to bring various points on the emissive surface successfully into action.

Cie pour la Fabrication des Compteurs et Matériel d'Usines à Gaz (addition to 479 226). *Application date 12th November,* 1936.

479 699.—Electrode assembly for a thermionic valve designed to reduce capacity coupling and to minimise the deposition of the "gettering" material used in the process of manufacture.

The British Thomson-Houston Co. Convention date (U.S.A.) 20th November, 1935.

479 961.— Cathode-ray tube in which the electrodes are mounted inside, but insulated from a metal cylinder coaxial with the glass tube.

Gluhlampen und Electriciats Akt. Convention date (Germany) 14th October, 1935.

480 263.—Electron multiplier filled with a series of secondary emission electrodes some of which are made previous to the electron stream.

Baird Television ; V. Jones ; and T. M. C. Lance. Application date 19th August, 1936.

SUBSIDIARY APPARATUS AND MATERIALS

478 594.—Method of making a radio cabinet from a single piece of plywood cut from stock with a minimum of waste.

G. W. Johnson (communicated by Philco Radio and Television Corpn.). Application date 22nd July, 1936.

478 637.—Construction of variable tuning condenser designed to withstand the effects of variations in temperature.

Marconi's W.T. Co. and T. D. Parkin. Application date 21st July, 1936.

478 646.—Means for suppressing high-frequency radiation, likely to interfere with broadcast reception, from the terminals of dynamos and similar electric apparatus.

The British Electrical and Allied Industries Research Association and L. H. Daniel. Application date 18th July, 1936.

478 711.—Construction of a gramophone pick-up suitable for mass production.

Cosmocord (communicated by W. M. Braun). Application date 22nd July, 1936.

478 840.—Light valve of the type in which the optical medium is traversed by mechanical waves of supersonic frequency so that it acts as a diffraction grating upon the incident light.

E. Traub. Application date 17th October, 1936.

478 842.—Light valve comprising a cell filled with a liquid medium which is subjected to the action of high-frequency mechanical waves.

I.M.K. Syndicate and M. J. Goddard. Application date 21st October, 1936.

478 924.—Light-sensitive cell arranged for receiving traffic signals on a motor car.

E. Falkenthal and E. Presser. Convention date (Germany) 28th March, 1936.

479 006.—Method of mounting the permanent magnet of a loud speaker so as to prevent loss of flux.

R. Bosch Akt. Convention date (Germany) 24th August, 1936.

479 060.—Electromagnetic pick-up of robust construction and provided with an air-gap of constant width.

Marconi's W.T. Co. Convention date (U.S.A.) 31st July, 1935.

479 575.—Multiple-unit piezo-electric crystal-oscillator set for use as a master-control over a range of frequencies.

Telefunken Co. Convention date (Germany) 14th May, 1936.

479 637.—Method of treating or preparing piezo-electric crystals to secure a predetermined temperature coefficient of frequency.

Standard Telephones and Cables (assignees of G. W. Willard). Convention date (U.S.A.) 1st May, 1936.

479 666.—Construction of dry-contact rectifiers capable of passing several milliamps of D.C. current from an A.C. supply of several thousand volts.

Suddeutsche Apparate-Fabrik. Convention date (Germany) 3rd August, 1936.

479 880.—Variable high-frequency industance coil of the so-called iron-clad type in which the windings are enclosed in a shell of finely-divided magnetic material.

Standard Telephones and Cables ; T. Johnston ; and L. W. Hallett. Application date 14th August, 1936.